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# American Electrician.

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## ELECTRICITY IN REFRIGERATION.

### ELECTRICAL EQUIPMENT OF A MODERN REFRIGERATING PLANT.

IN the commercial development of electrical energy for light and power purposes, no factor has been more potent than its adaptability to special applications. Of the many peculiar environments where the successful installation and operation of electrical apparatus would seem to be beset with almost insurmountable difficulties, the placing of an electrical distributing system in a building where moisture or even water and mechanical injury are the predominating factors to be combated, may be considered as one of the most severe cases.

When wires are installed in ordinary buildings every precaution is observed to eliminate the very elements with which the electric current must, in the instances above referred to, work in harmonious relation. Ordinary methods, therefore, need revising, and appliances which serve successfully in combating either one of these disturbing elements require careful combining so that the completed installation will possess the advantages of the highly insulated open work, so far as electrical isolation and reasonable freedom from any serious moisture is concerned, and at the same time be secure against disturbance.

Electric plants have been installed in many instances where such conditions of more or less severity were met and successfully overcome. Amongst such installations may be mentioned breweries, dye houses and refrigerating plants. When it, therefore, became necessary to install electrical apparatus for lighting and power purposes in the large new refrigerating, storage and distributing plant of the Manhattan Refrigerating Company in New York City, several already tried methods were available. The conditions to be met and the service desired by the owners were, however, of such a character as to warrant a decided departure from the ordinary path in such cases.

A short description of the refrigerating plant and its function will serve to illustrate the desirability of such changes. The main building occupies a ground area of 80 ft. x 100 ft., and has six floors and basement. This is supplemented by another structure, the lower part of which serves as the power house. Aside from the space reserved for offices, all other available floor space throughout the main building and the upper part of the power house are given up to cold storage rooms in which the temperature ranges from almost zero to simply a chilling point.

Every conceivable form of perishable food product is here stored, and, as is quite obvious, the utilization of every available cubic foot in these rooms is an economic necessity. The refrigerating service is, however, not limited to the demands within the building, but is also extended by means of heat-insulated underground pipes to the various stalls at the adjacent Gansevoort Market, the average distance of service at present being about 2800 ft. The system of distribution is such that no insulation against heat is required on the distributing mains, as no refrigeration is produced on the way, frost appearing only in the boxes of the customers.

The lighting, ventilating, elevating, power and partial pumping service for this storage building is entirely electrical. The power plant, located in the ground floor of the wing building, already mentioned, includes three 150-h.p. horizontal return tubular boilers, worked at 80 lbs., made by the Struthers & Wells Co., Warren, Pa. Aside

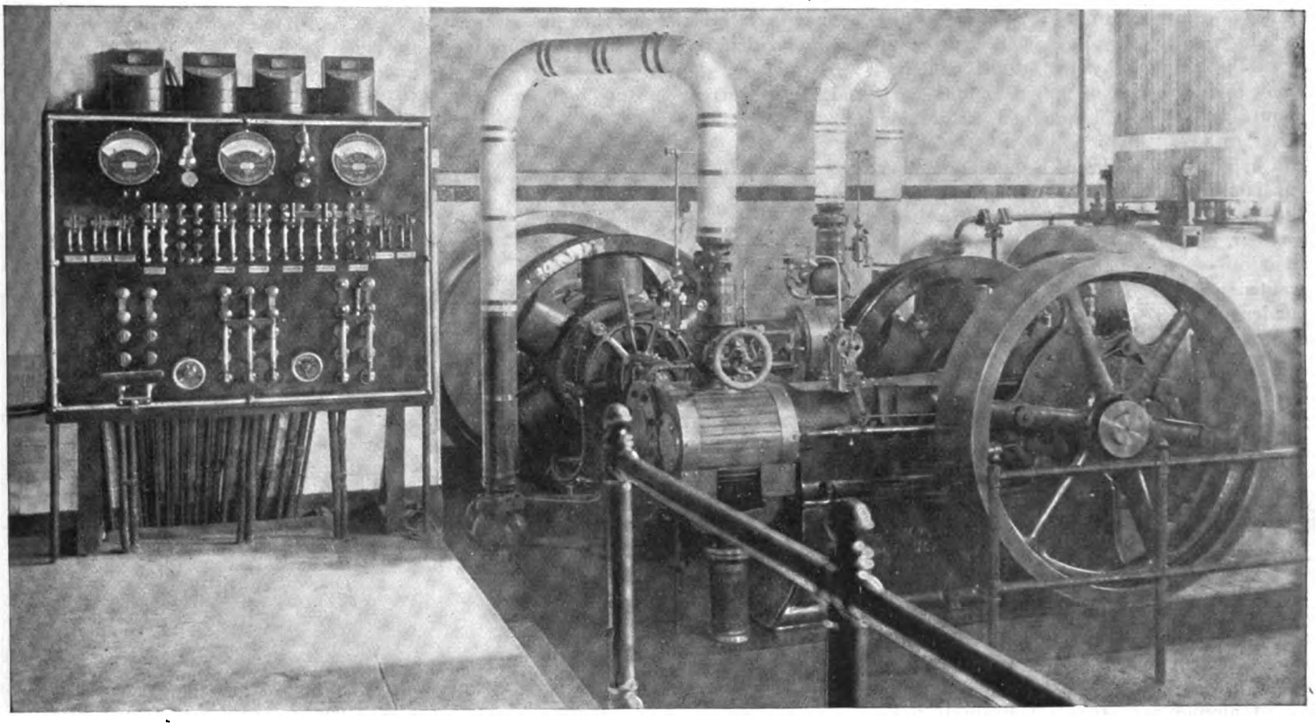


FIG. 1.—GENERATING PLANT AND SWITCHBOARD.

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from the use of steam for heating in the ammonia apparatus, as described later on, its use for power purposes is confined to the dynamo driving engines and the ammonia pumps, where for certain reasons steam instead of electric pumps were found desirable.

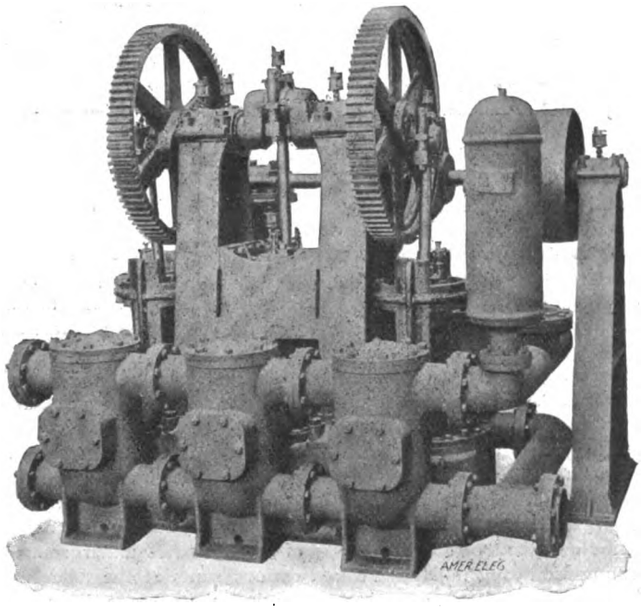


FIG. 2.—ONE OF THE BRINE PUMPS.

The refrigerating machinery is of the ammonia absorbtion type, using as a cooling agent ordinary liquid or aqua ammonia. At the present time two complete refrigerating machines (Fig. 4) are installed, although two more will eventually be placed. The capacity of each of the present machines is equivalent to 125 tons of ice melting in twenty-four hours. The process from the ammonia water to the cooling effect of the expanding liquid ammonia is about as follows: Ammonia saturated water, or aqua ammonia, is first heated in a still by means of steam coils, and ammonia gas is thereby driven off. From the still the hot gas passes through a so-called rectifier, which is a type of separator whose function is to free the gas from any entrained water. Next the gas passes to a condenser, where it is cooled by water flowing over the containing pipes, the reduction of the temperature and consequent pressure liquefying the now anhydrous ammonia, which then passes to the receiver. The actually utilized refrigerating effect is now produced by forcing the liquid ammonia through so-called expansion coils, by means of which heat is absorbed from the environment as the ammonia expands.

For nearly all service within the building the refrigerating medium consists of brine, which, after being thus reduced in temperature, is circulated by means of a proper piping system to the various rooms. For the central station service to the market the liquid ammonia is supplied through the underground pipes to the expansion coils, and acts directly on the surrounding air. The expanded ammonia, after thus performing its function, flows back to an "absorber," where the previously used water reabsorbs the gaseous ammonia and is then repassed to the still and used over again.

While the pumps for manipulating the ammonia are steam operated, the brine and water pumps are driven by electric power. For this purpose there are four triplex Goulds pumps (Fig. 2), having 8-in. stroke and 7½-in. cylinders. Each pair of pumps is operated by a 20-h.p. belted multipolar G. E. motor. In connection with this part of the installation it is particularly noteworthy that the room in which the motors are located is far from dry, yet one has been in constant operation for six months at nearly full load, and has in no way shown any bad results from this severe service.

Electric current is supplied from two generating units (Fig. 1), composed of Harrisburg Ideal simple horizontal engines, each directly connected to a G. E. multipolar compound 250-volt generator. The dynamos are of 50 and 75 kw. capacity, and operate at 280 and 260 r.p.m. Owing to the peculiar arrangement of the power house floors it was essential to provide a foundation for these units which is somewhat unique, as will appear from the illustration, Fig. 3. Pillars carry pairs of I beams, the transverse ones being supported at the other end by the wall. The space between these beams is floored by Z beams resting on the lower flanges. On these is placed a layer of beach sand, over which is laid concrete, the latter being covered with brick tiling, the engine bed resting on the latter. The peculiar feature of this foundation is the fact that the concrete bed at no point touched the framework of the building, being isolated therefrom by the beach sand filling on which it practically floats.

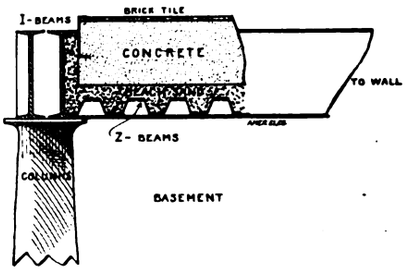



FIG. 3.—DETAILS OF FOUNDATION.

The main switchboard, shown in Fig. 1, is adjacent to the generating units, and is equipped with a separate light and power bus. The main dynamo switches are arranged to connect one machine to the light and the other to the power bus, and a three-pole switch is used to throw these two busses together and connect the equalizer from the dynamos for parallel running. Excepting under heavy power load the busses are run together. All switches and contacts on this board are silver plated to prevent any chemical action from the ammonia gas or the salt laden moisture, and together with the switchboard were furnished by the Crouse-Hinds Company, of Syracuse, N. Y.

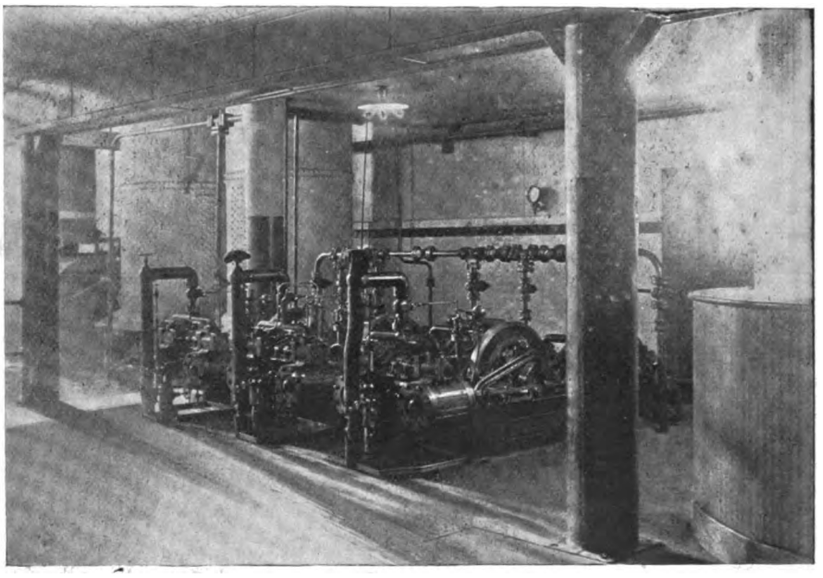


FIG. 4.—REFRIGERATING MACHINES.

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Since it was desired to operate both light and power circuits from the same generating units, it was decided to use 230 to 235-volt two-wire distribution throughout. With this comparatively high voltage a successful working under the conditions met with throughout the storage rooms would seem exceedingly difficult. In many places, particularly in the freezing rooms, the walls and ceilings are covered by a frozen film, and snow-covered pipes abound. The use of open wires on insulators was discarded, as this type of con-

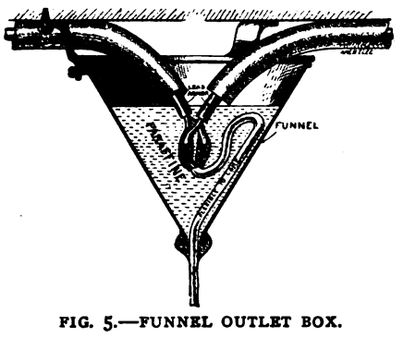



FIG. 5.—FUNNEL OUTLET BOX.

struction would be in no measure protected from mechanical injury in filling the rooms to their maximum capacity. It was necessary to encase the conductors and not only guard against mechanical disturbance, but to ward off all moisture from the current conducting wires and appliances.

The manner in which this has been accomplished is not only a decidedly striking departure from methods adopted in similar instances, but is also unique in the fact that the wire covering alone is used for electrical insulation.

Throughout "Safety Insulated" rubber-covered lead-armored twin wires run in "Loricated" steel pipe, and all the wires are sealed at the various outlets. The wire sizes range from 16 to 4 B. & S. As far as the actual conducting system is concerned, a rusted iron pipe enclosing an electrical conductor is but a minor matter, and

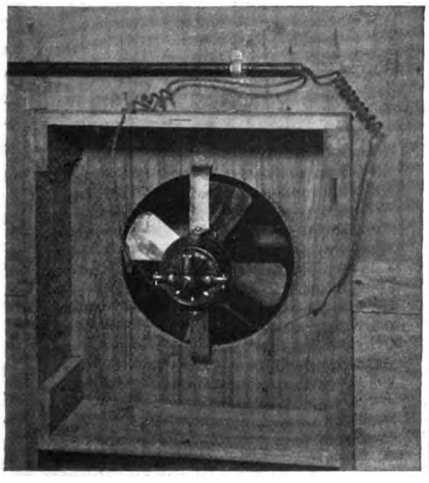


FIG. 7.—12-INCH AIR CIRCULATING FAN.

scarcely worthy of note. The real difficulties encountered were not in the pipe, but at the outlets. The piping throughout being thoroughly leaded and painted at the joints, serves as an excellent injury-proof jacket. For the cold storage rooms the feed circuits are run from the switchboard, and panels have been used on some of these at points exterior to the storage space, from whence the branches extend. Within the storage rooms exposed contacts are, however, entirely eliminated.

Up to the present time the paraffine-filled iron outlet box, shown in Fig. 10, has been used at most of the light outlets. This box is of the ordinary iron round type, and the paraffine was injected by means of an ordinary bicycle pump through the small hole shown. Difficulties experienced with this type of sealed outlet box have resulted in the placing of a number of very unique substitutes, shown in Fig. 5.

An ordinary agate ware funnel about 6 ins. in diameter at its flaring end is held downwardly projecting by means of a tripod supporting ring. The small end of the funnel through which the wire to the lamp passes is sealed, and slack wire sufficient for lowering is allowed inside. After the tap is made the funnel is filled with paraffine, and while the latter is still liquid the funnel is snapped onto its holding base, sealing up the ends of the lead armored

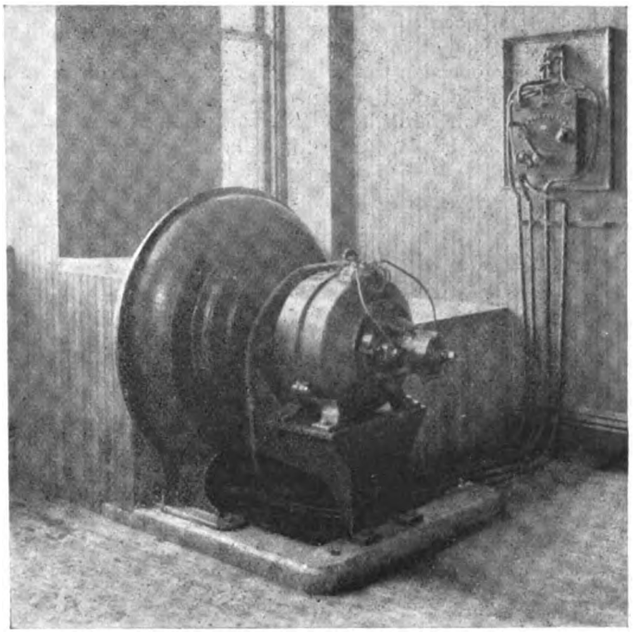


FIG. 6.—VENTILATING BLOWER.

wire outlets and the entire tap. It is intended to substitute this arrangement for the other type of outlet boxes. All lamp sockets are of the porcelain waterproof type, and are, in most instances, hung from these outlet boxes by means of twisted flexible rubber cable.

The necessity of a large number of local switching appliances introduced another difficulty. The cold storage space on each floor is divided into a number of separate rooms, arranged on each side of a central passageway which at its ends is entered through double doors. It was necessary to provide

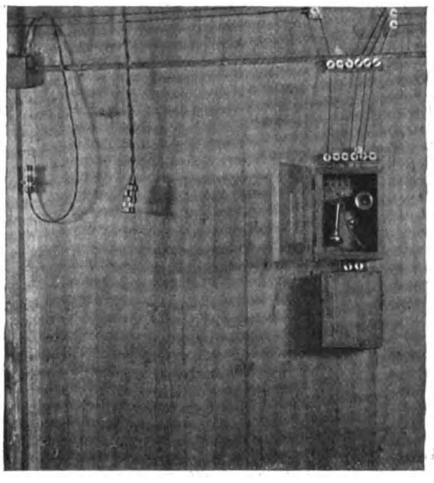


FIG. 8.—SEALED SWITCHES AND TELEPHONE STATION.



FIG. 9.—PASSAGEWAY, SHOWING ELECTRIC CONDUIT AND BRINE PIPES.

switches in this passageway for each storeroom, so that the lights and ventilating motors within could be operated from the exterior, and switches to similarly operate

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the lights in the central passage were needed at each entrance.

At first long-break, single and double-pole exposed contact, knife switches were installed, but moisture soon played havoc with these. Not only were leaks and partial short circuits constantly occurring, but, owing to the complete film of moisture covering the switch, the operator had to exercise particular care in order to prevent getting a taste of the current through his bare and frequently moist hands. As a

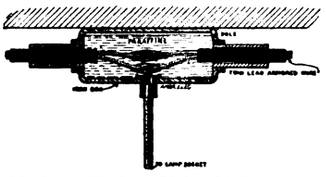


FIG. 10.—SEALED IRON OUTLET BOX.

consequence, the men employed in the warehouse would use somewhat severe means for closing and opening the switches. Hats, bars of wood, or anything else that came to hand would be used to knock the switches in and out. Certainly such usage alone warranted some substitute, but even with the greatest care the exposed contact knife switches soon showed the effects of the deteriorating environment. There are altogether about 300 16-c.p. incandescent lights and 50 motors throughout the cold storage rooms, which are controlled by about 65 local switches; single-pole for controlling the individual room and aisle lights which range from 2 to 6 on one switch, and double-pole for the various motors.

Since the matter of local switches was a most important element, a novel type of mercury contact switch was devised, having all conducting parts entirely sealed, and which could, therefore, be handled with perfect impunity. The two forms of this sealed switch are shown in Fig. 12.

The arrangement is exceedingly simple, consisting merely of a glass tube, corked and sealed at each end, and hung by a suitable cable from a paraffine filled outlet box. Terminal wires project through one of the corks into the interior. These terminal contacts are ordinary iron nails, and a small quantity of mercury, when this end of the switch is hung downward, connects across. The operation of the switch simply involves hanging the tube so that the mercury is at one end or the other. Iron instead of brass or copper terminals were adopted so as to obviate the rapid deterioration of the contacts. Double-pole switches are arranged by simply duplicating the tube. The arrangement of the three-point switches used at the entrances to the aisles so that the lights may be turned on or off from either end are particularly ingenious.

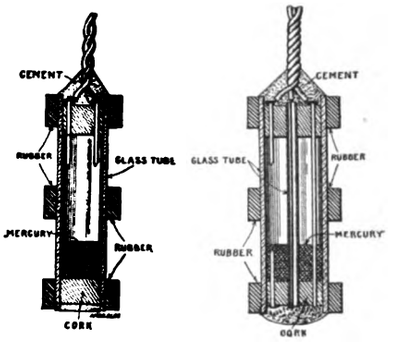



FIG. 12.—DETAILS OF SEALED SINGLE-POLE AND THREE-POINT SWITCH.

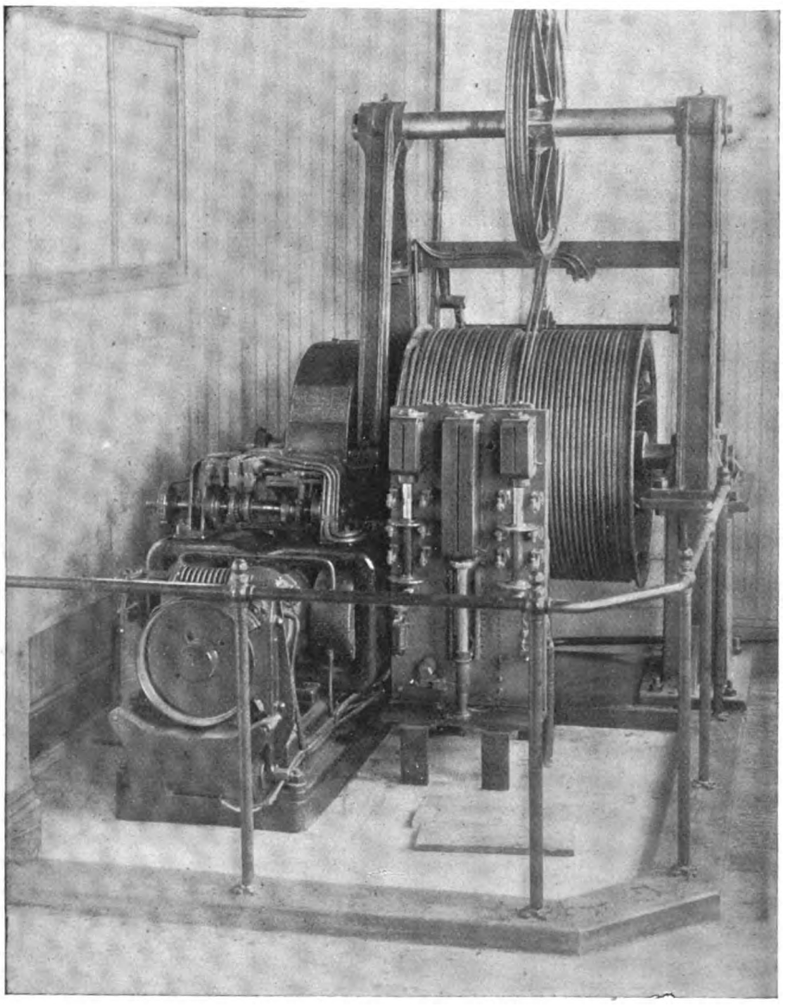


FIG. 11.—FREIGHT ELEVATOR.

An important item in the maintenance and care of storerooms filled with produce is at all times to keep the air in circulation and thus maintain an even temperature all over the room. In this work the electric motor has found a most fertile field. A large centrifugal blower, operated by a 5-h.p. motor, is used to clear the various passages and aisles. In the meat freezing room a fan, operated by a 1-h.p. motor, drives fresh air through the refrigerating coils at one end of the room and circulates it to the other.

Probably the most interesting application of motors for ventilating is the use of about forty small 12-in. Lundel fan motors, set in the partitions between the actual storage spaces and the coils, as shown in the diagram, Fig. 13, and in Fig. 7. The motor forces the air from the room through the coils and sends it through the openings in the false ceiling, thus keeping the temperature even throughout. Rooms in which fruit, eggs, etc., are stored, and which need but a chilling, but even, temperature and an air circulation to prevent mold, are thus equipped. Usually two motors are placed in each room. They are connected to the circuit by the sealed double-pole switches, exterior to the rooms, and their speed is controlled by rheostats placed on the inside wall. The drip pump in the boiler room is also electrically operated, and a G. E. 5-h.p. motor is used to drive the tools for pipe working in the machine shop.

In addition to the motor equipment, already mentioned, two large electric freight elevators have been installed, one on each street front of the building. These are Sprague drum-winding, worm-gear machines, and are provided with electric switch control, not only from the car, but also at each floor landing. The peculiar advantages of electrically operated elevators for establishments of this nature is most strikingly illustrated by the smoothness and facility of operation, but particularly by the absolute safety from interference in operation, a feature inherent in the peculiar control system here installed. This is so arranged that if the car is being loaded or unloaded at any floor the switches on all the other floors can be made inoperative

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by locking any one of them. The advantage of this arrangement where, as here, it is frequently necessary to bring the car to any floor from another, and where anybody is permitted to operate it, is obvious. Each of these elevators has a capacity of 6000 lbs. at 80 ft. per minute. They are counterbalanced for part of the load carried, and their operation on a circuit also carrying lights has proven most satisfactory.

In addition to the light and power equipment of this up-to-date refrigerating plant, a Schmidt & Bruckner interior telephone system has been installed, centering in a small station located in the main office. As with everything else electrical, various provisions had to be made against moisture. Many of the stations are in the aisles on each floor, and the manner of placing the apparatus and

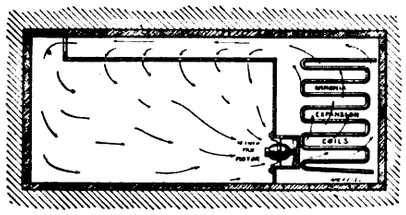


FIG. 13.—AIR CIRCULATION IN COOLING ROOMS.

local battery in paraffine-soaked wooden boxes, separated from the wall by porcelain insulators, is shown in Fig. 8. The boxing of the instruments was necessary owing to the possibility of mechanical injury, and extension call bells were, therefore, used. The ordinary box bell arrangement was, however, found unsatisfactory, resulting in the design of a novel hanging waterproof magneto bell, shown in Fig. 14. All telephone wires are run on porcelain knobs.

Up to the present time the installation seems to have met all expectations. Changes and modifications have, it is true, been necessary, but there seems to be every reason to believe that any additional obstacles can be as well overcome as those already met with. The designer of the complete electrical installation, Mr. Chas. H. Warner, has given this type of construction work a good deal of attention,

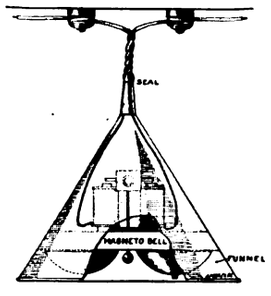



FIG. 14.—WATER-PROOF MAGNETO BELL.

and his many departures from the beaten track will probably pioneer other similar installations. The actual installation work was done by the Starr Engineering Co., who also installed the complete refrigerating plant and street pipe line.

In conclusion a word may be said in another direction which, although perhaps not of any direct bearing on the plant described, has yet a certain relationship which should not be overlooked. It would appear that refrigeration might in many cases be profitably coupled with the production of electrical energy. Electric central stations might well consider this opportunity for employing energy when it can well be spared. Refrigeration would, in fact, furnish an ideal day load.

## COUNTER E. M. F. OF MOTORS.

BY PROF. A. F. MCKISSICK.

The following experiments have been found to give students a clear conception of the nature of the counter e.m.f. of motors. The first one is found in Nichol's Laboratory Manual, Vol. II., and was devised by Prof. G. S. Moler, of Cornell University. The second one, very closely resembling the first, originated in the electrical laboratory of the Alabama Polytechnic Institute.

The connections for the first mentioned method are shown in Fig. 1. A is a small series generator without regulator; B is the shunt motor to be experimented with; C, a shunt dynamo used for exciting the fields of B; e is an ammeter and d a voltmeter, both of which will read right and left, thus show-

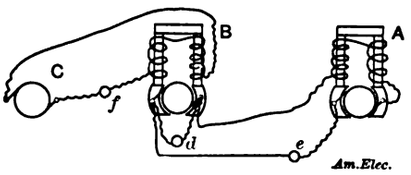



FIG. 1.—DIAGRAM OF CONNECTIONS.

ing direction and values of currents; f is an ammeter indicating the field current of B. With the field of B excited by C, A on being started up will furnish current to the armature of B, and cause it to make a few revolutions in one direction and then reverse. The instruments d and e will also show reversals. By supplying sufficient friction to the pulley with the hand, the armature can be made to rotate continuously in one direction. An increase in the strength of the field of B reduces the number of revolutions before reversing takes place, and a decrease in the field causes the reverse.

The explanation of this is that the counter e.m.f. of armature B overpowers the impressed e.m.f. of A, causing a reversal of the current in A, and therefore a reversal of the direction of rotation of B. By means of friction, the armature of B is not allowed to reach that speed necessary for reversal, hence its continuous rotation in one direction. Increasing the field strength of B increases the counter e.m.f. of B, necessitating therefore a lower speed for reversal. Decreasing the field strength decreases the counter e.m.f. of B, therefore requiring a higher speed for reversal.

Taking up the second experiment, C is a shunt dynamo, used for exciting the fields of B, which is a shunt motor with armature and field windings separated. A is a Thomson-Houston arc dynamo with regulating apparatus as shown; a and b, ammeter and voltmeter respectively, of the type used in experiment I. With the fields of B excited, on furnishing current from A to the armature of B the latter will rotate continuously in one direction, inasmuch as A is self-regulating and does not allow the counter e.m.f. of B to overpower its impressed e.m.f. On closing the switch c, thereby

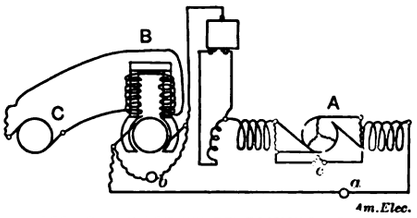



FIG. 2.—DIAGRAM OF CONNECTIONS.

stopping the generation of current by A, B being up to a high speed begins to act as a dynamo, and what before was the counter e.m.f. of motor B now becomes the impressed e.m.f. of dynamo B. This impressed e.m.f. of B sets up a current through the fields of A, reversing the polarity of the same. By opening the switch c again, we make A generate current, but now reversed, and therefore the armature of B will rotate in opposite direction. The instruments a and b also will indicate these reversals.

## THERMODYNAMICS DEFIED.

In a circular letter of recent date, with a New York address, the attention of steam users is called to a "steam regenerator" of marvellous properties, which, it is claimed, makes the steam engine a "perfect thermodynamic machine;" converts all the exhaust steam into live steam, and, besides, is a condenser that does not require condensing water and a feed-water heater that heats all the feed to 300 degrees! The invention consists in taking "the waste product known as exhaust steam after it leaves the engine or feed-water heater, and, by a system of compression, re-evaporation, sub-heating and mixing with live steam, brings its temperature and pressure up to that of the steam in the boiler, to return this exhaust, now revitalized, into the main steam pipe to engine—not to boiler. It will be seen that this makes a closed system of an engine and boiler, and, while adding more machinery to the combination, practically returns all heat not used in work to reservoir, to be used over again. It will also be seen that this machine is also an auxiliary generator, doing part of the work of the boiler." It is claimed that the use of such a device means a revolution in steam-engine practice, but the direct statement to this effect is somewhat ambiguous, and astonishingly conservative in view of the claim that the system returns to be used over again practically all the heat otherwise wasted; for it merely says: "If, by any system of working exhaust steam, we can raise this (10 per cent efficiency) to 20 per cent efficiency, we have something that no steam user can afford to be without."

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## THE ELECTRIC FURNACE.

BY LIEUT. F. JARVIS PATTEN.

It may be stated in general terms that the electric furnace, even in its comparatively extensive applications, to-day consists of little else than an arrangement of devices and parts, the operation of which make the exceedingly high temperature of the electric arc available for commercial use. Strictly speaking, this temperature should be very close to that required to volatilize carbon, but, in speaking of the temperature of the electric furnace, its value cannot be stated in such definite terms, because there are several widely different temperatures at work.

M. Violle, by means of extensive research in this field, established the temperature of the positive electrode at a maximum of 7000 deg. F., and that of the negative pole at about 5600 deg., whereas the arc itself between poles may be as high as 8600 deg. F., this temperature, according to the determinations of this eminent authority, being independent of the size or thickness of

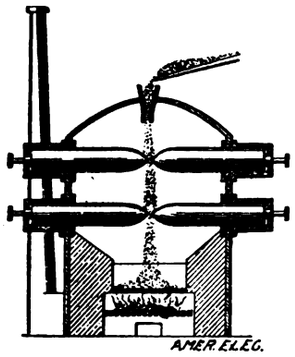



FIG. 1.—PICHON FURNACE.

the arc, as well as the strength of the current.

It is this high temperature, the highest applied in industrial processes, that opens such a broad field for the electric furnace, and brings into play a new set of chemical affinities heretofore accepted as fixed and definitely controlling the union or dissociation of certain elements, doing so, however, only within certain limits of temperature, which limit being exceeded, the affinities change and the elements combine in a way to make entirely different combinations.

This alteration of chemical affinities finds excellent illustration in the production of calcium carbide ($CaC_2$) from the union of calcium and carbon when subjected to the temperature of the electric arc. At the lower temperature the calcium is firmly bound to the oxygen required to form the oxide CaO, common lime. This, when finely divided and mixed with powdered coke (carbon), the latter unites with both the elements forming lime, making with one $CaC_2$, or calcium carbide, and with the other carbon monoxide, or CO, according to the following reaction: CaO (lime) + 3 C (carbon) = Ca $C_2$ (calcium carbide) + CO (carbon monoxide). Such is the simple chemical change by which calcium carbide is formed by subjecting lime and coke, which contains its elementary constituents, to a very high degree of heat.

At ordinary temperatures, however, the resulting carbide is comparatively unstable, being chemically disintegrated by mere contact with cold water, the carbon attacking the hydrogen of the latter with great avidity to form acetylene gas ($C_2 H_2$), while the calcium unites with its oxygen to form lime.

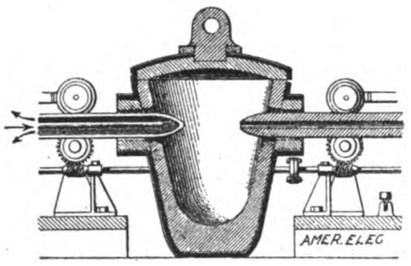



FIG. 2.—SIEMENS FURNACE.

The first electric furnaces mentioned were built with the expectation that they would offer improved methods of smelting ores, and doubtless a chief reason why they received little or no practical development is because they antedated our present methods of generating and controlling the electric current. They are therefore only interesting as the earliest examples of the art.

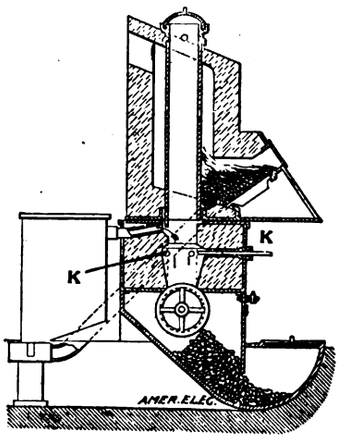



FIG. 3.—FAURE FURNACE.

Such a one is the Pichon furnace, Fig. 1, which dates back to 1853, and which is the evident precurser of several later types. The mineral to be operated upon is allowed to fall through arcs maintained between separate pairs of electrodes, placed one set vertically over the other. Another of the same year and of English origin is strikingly suggestive of the Cowles furnace of 1887. These examples suffice to show that the art is older than the modern dynamo, and that, notwithstanding the fact that Siemens in 1879 was the first to reduce the electric furnace to something like a practical form, he was by no means the first to formulate or invent some kind of an electric furnace.

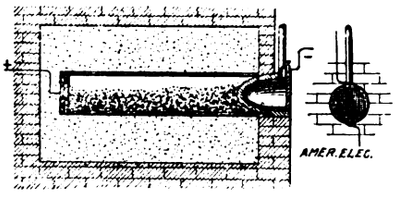



FIG. 4.—EARLY COWLES FURNACE.

The essential features of the Siemens furnace—strictly speaking, an electrically heated crucible—are given in Fig. 2, taken from the English patent, a type of which was exhibited in operation at the Paris Exposition of 1881. In this device the crucible was made of carbon, as well as the electrodes, A, and a carbon cover closed the vessel; there was also provision for keeping the carbons relatively cool outside the furnace by means of a continuously circulating stream of water. Siemens presented about this time several different forms which, taken as a class, present all the more important elements found in the electric furnace of to-day, and for this reason he may be regarded as the founder of the art. Between the work of Siemens in this field and that of Cowles, who was first to use the electric furnace on a true commercial scale in the later eighties, we find the name of Camille Faure, whose work in this direction is evidenced by an English patent of 1882, describing an electric furnace for smelting iron ore by using a system of multiple arcs between a series of horizontally radiating carbons, K, Fig. 3.

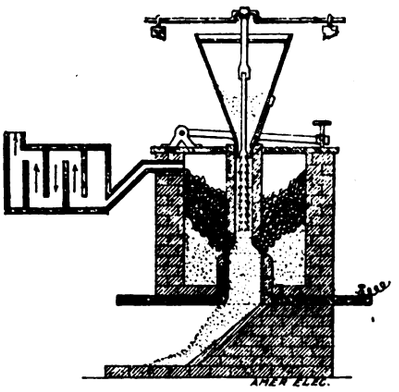



FIG. 5.—COWLES HOPPER FURNACE.

In the early eighties the Cowles brothers patented and operated successfully in England quite a variety of electric furnaces, which were used chiefly for reducing metallic oxides. The earlier forms built by them were for zinc ores, but later the oxides of barium, magnesium and aluminum were treated in a similar way. An early type of these is shown in Fig. 4. It consists of an interior cylinder of silica or similar non-conducting refractory substance.

This cylinder, which contained the material to be operated on, is embedded in powdered wood charcoal to retain the heat. A carbon slab closing the cylinder at one end forms the positive electrode, and a graphite crucible closing the other end of the cylinder is the negative electrode. A charge consisting of a mixture of ore and coke is brought to incandescence in the cylinder by the passage of the current.

A number of furnaces were designed and operated by the Cowles brothers for several years that differed from each other only in

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the arrangement and construction of the electrodes and the system of charging or of feeding the material to the furnace. One designed for continuous operation is shown in Fig. 5. One electrode is a vertical carbon tube secured to the lower extremity of the feeding hopper. The lower electrode is a somewhat larger tube carried by the furnace floor. The whole arrangement is inclosed by walls of refractory brick. A mixture of powdered carbon and lime completely surrounds the lower electrode, serving to confine the heat to the zone between the electrodes. The charge is forced down by a screw feed working in the upper tubular electrode, while the escaping gases incident to the reaction are led off to a condensing or collecting apparatus shown at the left.

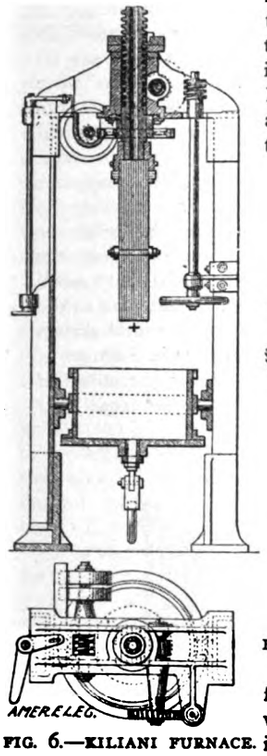



FIG. 6.—KILIANI FURNACE.

Early in the use of the electric furnace, and particularly in the production of carbides, it became evident that the arc between electrodes confined itself almost entirely to the path offered by the first carbide formed, this material being a much better conductor of the electric current than the carbide and lime charge at first attacked by the arc. As soon as the charge began to be worked effectively, therefore, energy was lost by the tendency of the current to follow the new low-resistance path. This difficulty gave rise to numerous furnace systems, in which it was attempted to keep the arc moving about from point to point, so as to get at new material and not waste the current by keeping that which had been formed in a state of incandescence. Most of these attempts were mere mechanical devices for moving one electrode about while the other remained fixed.

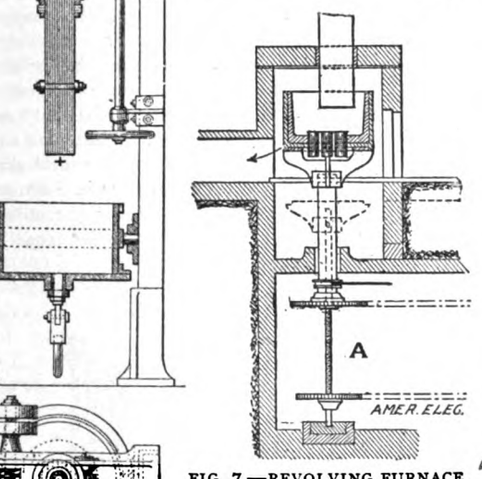



FIG. 7.—REVOLVING FURNACE.

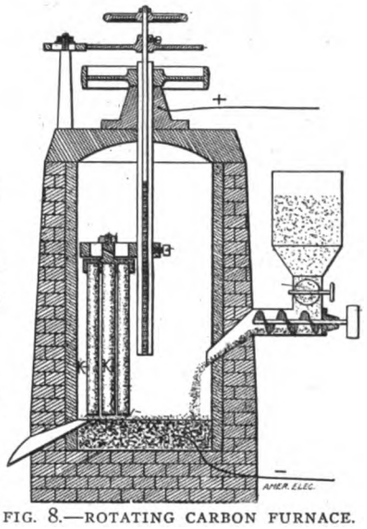



FIG. 8.—ROTATING CARBON FURNACE.

The Kiliani furnace, Fig. 6, is one of the first of this type. The upper electrode is swung in such a way that it can be given motion in two horizontal directions, and therefore by a combination of these two motions the electrode can be rotated. A recently patented French furnace having the same objective in view is shown in Fig. 7. Here the lower electrode, formed of a group of carbons, forms the central base of a crucible or pot, the purpose of which is to hold the charge. This pot turns upon a central vertical axis, A, being driven slowly by machinery. The upper electrode, arranged vertically, is fixed in position, but its axis is placed eccentrically to that of the crucible, from which it results that as the pot turns fresh material is continually brought beneath the arc.

Another device, the illustration of which, Fig. 8, is taken from a recent American patent, has a rotating vertical carbon, K, the end of which is thus made to traverse over the surface of a fixed horizontal table forming the lower electrode.

Two English inventors, Rogerson and Slatter, however, as early as 1888, were the first to show what may be fairly styled a distinct and novel type of furnace, in which the chief object was to control the position of the arc between electrodes by placing it in a magnetic field. In view of this attempt, made public so many years ago, and indicating a simple method of moving the arc without mechanism, it is surprising to see so many recent methods of accomplishing the same result by apparently clumsy and mechanical methods.

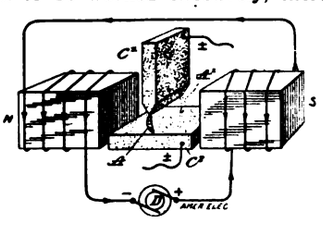



FIG. 10.—MAGNETIC CONTROL OF ARC.

In the furnace mentioned, Fig. 9, the arc between electrodes is placed in a strong magnetic field which will deflect the arc upward or downward, according to the direction of the lines of force of the field, and by reversing the field the arc can evidently be directed upward or downward at will. In view of this evident hint, it is strange that the principle shown should not have received broader application—to that, for instance, of keeping the arc continuously in motion in either a reciprocating or a rotary manner.

Several solutions of this problem were worked out by the writer, giving a system of furnaces with arcs which are not only moved over quite large working surfaces, but were made to move automatically and without the use of any auxiliary mechanism whatever and while both electrodes remained fixed in position. In one form the arc is made to traverse to and fro at right angles to the direction of the current, and in another it is made to rotate in a plane at right angles to one of the electrodes.

The first of these is illustrated in Figs. 10 and 11, the first indicating the application of the principle used, and the second giving a cross-sectional view of a traversing multiple arc furnace. Referring to Fig. 10, $C_1$ and $C_2$ are carbon slabs given the shape of rectangular blocks and placed at right angles to each other at arcing distance. The arcing space is placed in the field of the magnet N S, and this, by well-known principles, will hold the arc in the position $A_1$, its tendency being to go out of the magnetic field in a direction at right angles to the lines of force.

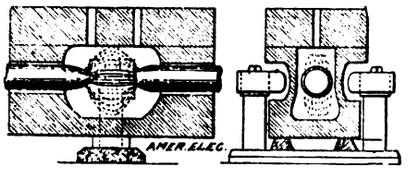



FIG. 9.—READMAN FURNACE.

If, however, the magnet is turned through 180 deg., so that the relative positions of the N and S poles are reversed, the arc will then go over to the position $A_2$ at the other side of the magnetic field. Evidently, then, if the magnet N S could be revolved or spun around the vertical middle line of the carbon slab $C_1$, then the arc would, in order to get out of the changing magnetic field, move to and fro across the lower edge of the vertical carbon, and thus be kept reciprocating as the magnet revolved.

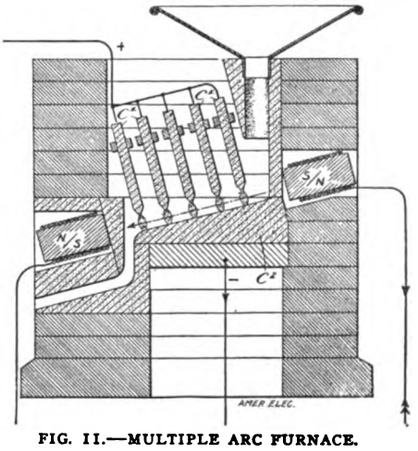
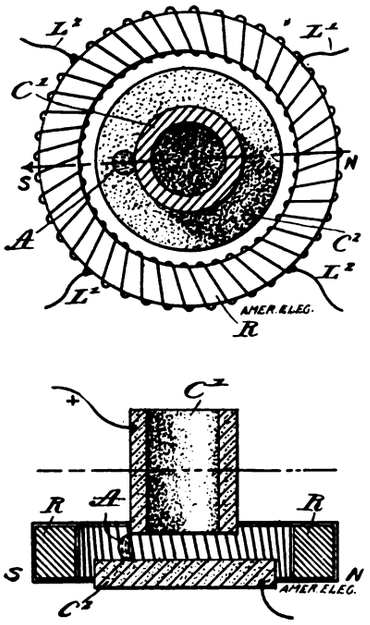



FIG. 11.—MULTIPLE ARC FURNACE.

It is evidently not necessary, however, to revolve the magnet, as described to get this result, for it would do just as well to let the magnet remain fixed in position and

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reverse the magnetism periodically. And, again, there are clearly two ways of accomplishing the same result without moving any part. Thus, it matters not whether we put a direct current between electrodes and reverse the field magnetism periodically, or let the magnetism remain constant and periodically reverse the direction of the current betwen the electrodes. Thus, if we use an alternating current for the furnace work, an ordinary electro magnet of unchanging polarity embracing the arcing space in its field will cause the arc to recip-




FIGS. 12 AND 13.—ARC IN ROTARY FIELD.

rocate from side to side with each reversal of the current direction.

Fig. 11 indicates a multiple arc furnace involving this principle. A number of carbon slabs, $C_1$, are arranged parallel to each other at right angles to another, $C_2$, that forms at the same time the inclined base of the furnace and an opposite electrode to all the others. The magnet N S is built into the furnace walls in such a position as to embrace all the arcs in its magnetic field. If direct current is used between electrodes to do the smelting, then the magnetism of the surface magnet is slowly reversed, causing the arcs to all move to and fro across the furnace floors.

An evident and interesting variation is to connect the upper or vertical electrodes in series in such a way that the current flows up in one and, at the same time, down in the next, and so on throughout the series. Under these conditions one arc will be going from right to left across the furnace base while the other is going in the opposite direction from left to right.

The several types of furnace in which the arc is made to take up a rotary motion around the vertical electrode are all exemplified in principle by Figs. 12 and 13, which represent horizontal and vertical sections, respectively. The vertical electrode, $C_1$, is made preferably in the form of a tube, which at the same time serves as a passage through which to feed the material to the arc. A circular or ring magnet, R, surrounds the arcing space, and within the peripheral space of the ring a rotating magnetic field, A, is maintained by exciting its winding with slowly reversing multiphase currents, $L_1$, $L_2$. Under these circum-

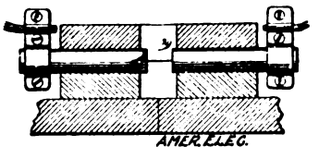



FIG. 14.—BORCHERS FURNACE.

stances, the arc between the upper tubular carbon electrode and the lower slab, also the base of the furnace, will be made to rotate around the lower end of the tubular electrode in its continuous effort to get out of a rotating magnetic field.

One other furnace system deserves mention for the reason that it represents a distinct type, and, though it is to be found among the earlier forms, it has not come into extensive use, although copied in several recent forms. Reference is made to the Borchers furnace, first made by the eminent German chemist and electro-metallurgist of that name, and may be described as a furnace of the incandescent type in contradistinction to those previously described which, for sake of distinction, may be considered as of the arc type.

In the Borchers furnace, Fig. 14, two large carbon electrodes take a heavy current inside the furnace, where these carbons, instead of being placed at arcing distance from each other, and an arc sprung between them, they are joined to each other by a comparatively small pencil of carbon, which, in fact, is made too small in cross section to carry the current brought in by the large carbons without fusion. The re-

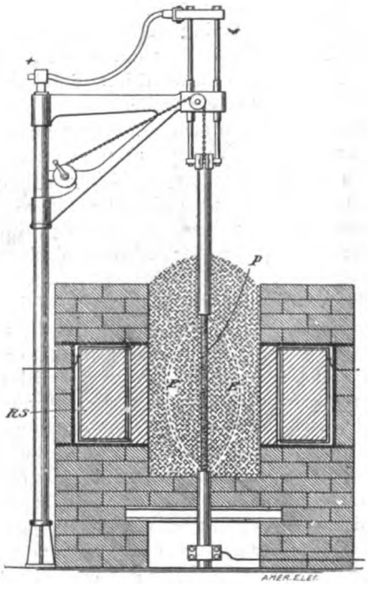



FIG. 15.—KING-WYATT FURNACE.

sult is the carbon pencil is soon brought to a state of high incandescence and finally fused. At this stage the heat is sufficient to fuse some of the mixture of carbon and lime immediately surrounding the pencil. When this is accomplished, the fact being indicated by a rapid increase in the rate of current flow, the carbon termini now connected only by fused material are gradually drawn further apart, thus bringing more unfused material under treatment. In fact, from this stage on, that is to say after a mass of fused material has been formed between electrodes, the operation of the furnace differs in no essential particular from that of a furnace of the arc type. The difference of the two methods appears to reside only in the manner of starting the operation. There is no essential difference in the construction or operation of the earlier furnace of Borchers and that known as the King-Wyatt, Fig. 15, patented in the United States years after the same system had been reduced to practice in Europe.

A slight variation, however, the object of which is to greatly increase the capacity of

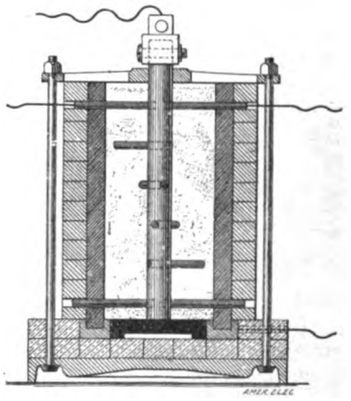


FIG. 16.—MULTIPLE CARBON FURNACE.

the furnace at one charging, is shown in Fig. 16. In this arrangement a large number of carbon pencils are introduced as radiating branches from a central main electrode at the middle of the furnace, and the circular wall thereof, also built up of carbon blocks and forming the other main electrode. The small radiating pencils may be a dozen or more in number, and may be either operated singly in rotation or, if current enough is available, the entire lot may be operated simultaneously in multiple arc. In either case there will be a number of nuggets made at one charging corresponding to the number of pencils operated, and thus save the heat lost recharging and in the cooling of the entire furnace at each formation of a single nugget.

In this way it is possible to approximate, in some degree at least, to what is generally termed a continuous process, by which is meant one in which material is continually fed into the furnace at one point and removed by a process of flow from a nozzle or tuyere in the shape of fused carbide.

Many advocates of different furnace systems claim to have such a continuous method of operation, but none that has ever come under the writer's observation has proved to be so in fact.

Most furnaces in use at present in the United States are of the single arc type, with two vertical carbon electrodes, the upper one being movable vertically and the

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lower one fixed, the two being separated by raising the upper one as the material between them passes to the fused or new chemical state. This is continued until a nugget three or four feet long is formed, generally circular in cross section and tapering toward the ends to the size of the electrodes.

The more recent forms differ only in the manner of feeding the material, arrangements for withdrawing and recharging, and the additional feature that many of the modern furnaces for making carbide of calcium are multiple arc, or multiple electrode furnaces all worked simultaneously, thus giving half a dozen nuggets at one operation.

The more recent of these furnaces are about 30 ft. high, having five or six arcs each simultaneously in operation, and turning out 1500 to 1800 lbs. at a single operation lasting about four hours.

The carbons in these furnaces are built up of slabs of carbon bound together so as to produce an electrode having a cross section about 6 ins. x 9 ins. Evidently the current carrying capacity of these electrodes is quite considerable.

As to the voltage used, practice has thus far seemed to indicate that a voltage of sixty-five to seventy gives the best results, it being attempted to maintain this factor as nearly as possible constant, and vary the current in proportion to the quantity of material under action of the current from time to time. This voltage at, say, 400 amps. of current, corresponds to from 30 to 40 h.p. per electrode. Several of the recent forms of furnace, however, take much more current—nearer 1000 amps., and using from 75 to 100 h.p. per stack.

The output of carbide on an average is 0.4 lb. per electrical hour, or about 200 h.p. hours per day of twenty-four hours per ton.

It is evident from all this that the cost of carbide at the furnace is altogether dependent upon the cost of power at the furnace, and that made from cheap water power that is not too far from commercial centers will always be very much cheaper than that which can be produced from any other source of energy.

As to the origin of the carbide process now worked, there has been considerable controversy that has failed to lead to any very definite result. All German authorities credit their very eminent physicist, Dr. Borchers, with having first made carbides of the alkaline earths by use of the electric furnace, and there is little doubt that he was actually the first to get some results of this description. The French are equally enthusiastic in support of the claims of M. Moisson in this field, and, while admitting that Dr. Borchers made the earlier attempts in this direction, he did not obtain pure carbides, whereas, Moisson, at a later, did obtain such results by more advanced methods of the same general description. M. Moisson's researches have at all events been most thorough and far-reaching in their exposition of the wide possibilities of the electric furnace.

Between these claimants and the evidence brought by their respective advocates, the claim of Wilson, an American inventor, to have first discovered carbide, accidentally, as a by-product of the production of aluminum by the electric furnace process, seems to lack real foundation. Although this inventor may have independently discovered calcium carbide, his date was too recent to admit of any claim to being the first discoverer of the material or process.

# Three-Phase Electric Railway.

## A SWISS THREE-PHASE MOUNTAIN ELECTRIC RAILWAY.

Since the installation of the first alternating current railway in 1896 at Lugano, and doubtless owing to the very satisfactory results obtained in the operation of this plant, a number of new roads in Europe have been equipped on the polyphase system. One of the latest of these is a three-phase line from Stansstadt to Engelberg in Switzerland, which road has an additional interest from the fact that part of it climbs a 25 per cent grade.

Referring to the profile of the railway in Fig. 3, the track for a distance of 11.2 miles is of the ordinary type, traction being accomplished by adhesion; then for a distance of a little short of a mile the roadbed is furnished with a rack-rail, the grade on

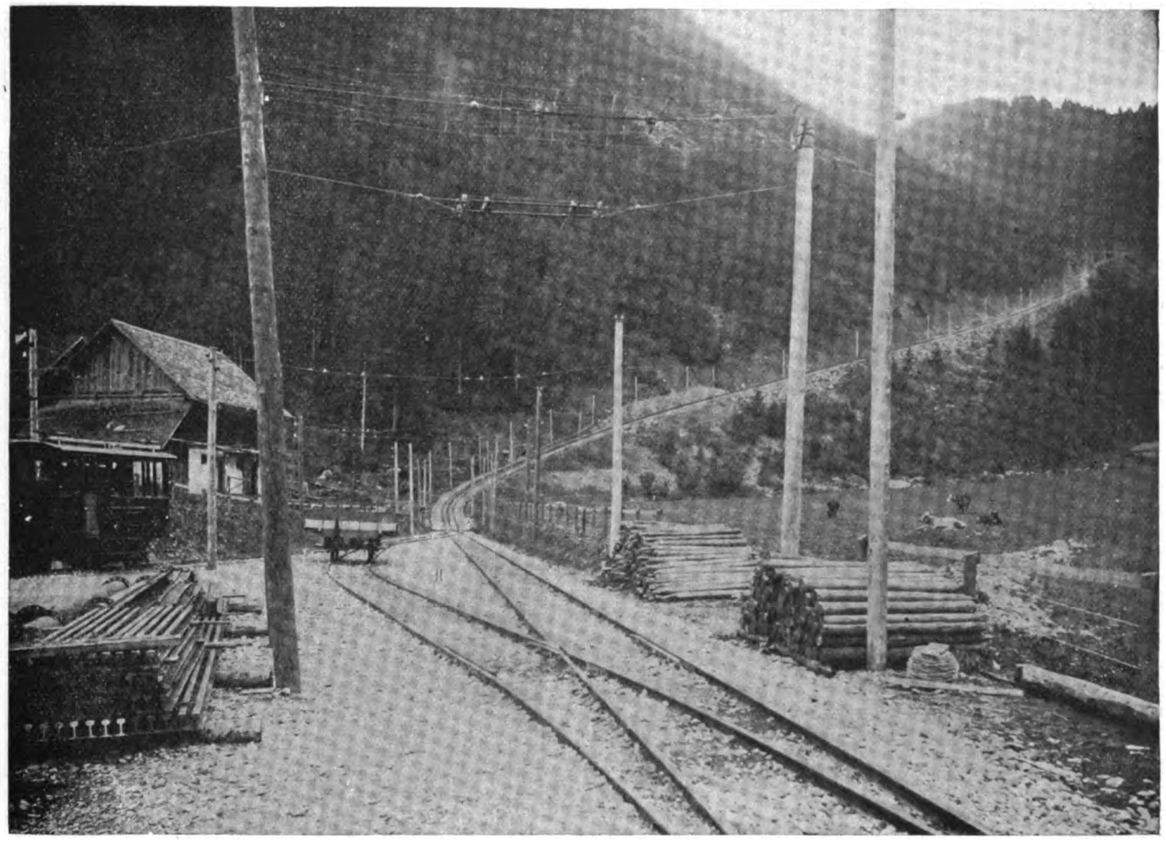


FIG. I.—POWER HOUSE, AND FOOT OF INCLINE.

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this section being an average of 25 per cent.

The first-mentioned section of track is operated by single motor cars which are

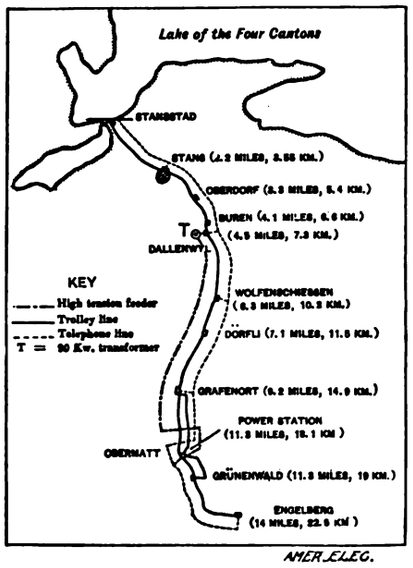



FIG. 2.—MAP OF LOCATION AND TROLLEY LINE.

designed to be capable of drawing one trail car. At the foot of the steep incline an electric locomotive is run up behind the motor car, and without coupling the train proceeds up the grade under the power of the locomotive alone. On arriving at the upper point, the motorman of the car turns current into the motors and the car proceeds to the end of the line under its own power without being obliged to uncouple from the locomotive. A view of a train going up the incline is shown in Fig. 6.

To descend, the car runs on the rack section and the locomotive is coupled. When they arrive at the bottom of the incline the motor car proceeds independently after about two minutes' delay for uncoupling.

The speed of the cars is absolutely constant, being at the rate of twelve miles over the long portion of the road, and three miles going up the incline. While operating under constant speed may have disadvantages under some circumstances, it has the advantage that the motorman is not able to waste current by lack of judgment or take liberties with the running schedule, while the manipulation is confined to closing a switch and slowly cutting out a starting resistance.

The power house (Fig. 1) is located at

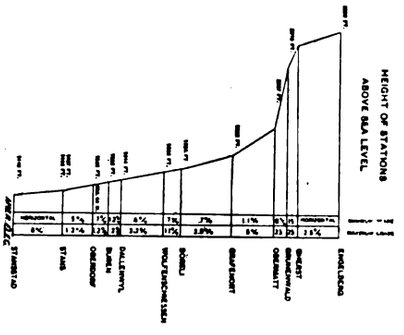



FIG. 3.—PROFILE OF ROAD.

the bottom of the rack incline, and contains two three-phase generators (Fig. 5) of 200-h.p. each, driven by turbines at 65 r.p.m., and excited by two 10-h.p. direct current machines, each driven by a small turbine. The current is generated at 750 volts and 35 periods, and is conducted directly to the trolley wire supplying the section immediately adjoining the station. In addition, feeders are run to the extremities of the sections having the highest grades, at Grafenort and Grunewald. Fig. 2 shows the distribution of current. To feed distant sections the voltage is stepped up to 5000 and then lowered to 750; there is a 90-kw. transformer for this purpose at the power house, the lowering transformer of the same capacity being 6.9 miles distant.

In Fig. 7 are represented the generating and distributing circuits. G is a 750-volt three-phase generator; E a 110-volt direct-current exciter; R. a regulating rheostat, and T a 750-5000-volt transformer.

There are two trolley wires of a size somewhat larger than No. 1, B. & S. gauge (75 mm.), the ground return serving for the third conductor of the three-phase system.

The rolling stock is composed of two electric locomotives, five motor cars and four freight cars. The locomotives (Fig. 10), which have a weight of 16.5 tons, draw the cars on the rackrail section, as well as handle the freight trains. These locomotives are mounted on two axles, and are equipped with two motors of 75 h.p. each, and drive the rack gear wheel by a double reduction gearing as shown in Fig. 4. The motors operate at a speed of 650 r.p.m., and the speed on the rackrail is 3 miles per

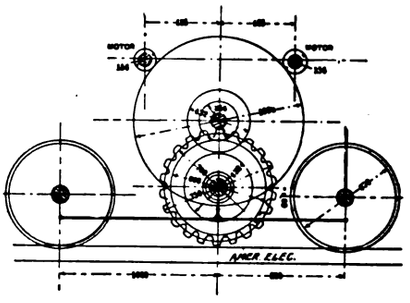



FIG. 4.—RACK DRIVING GEAR.

hour. In addition, the locomotives are so built that the rack gear can be disconnected, and they can operate on the ordinary sections at a speed of 8 miles per hour.

The duties of the motorman are very simple. He closes first the main switch and slowly cuts out the resistance which is in the circuit of the motors. The motors operate then in synchronism with the generators of the power station and at a constant speed, independent of the load drawn. When ascending a grade of 25 per cent and pushing a motor car completely loaded, the locomotives absorb an average of from 95 to 100 amps. at 750 volts. In descending and with the same conditions of load, the motors furnish a current from 60 to 65 amps., going up to a maximum of 75 amps. The current is taken from the overhead wires by means of two sliding bow con-

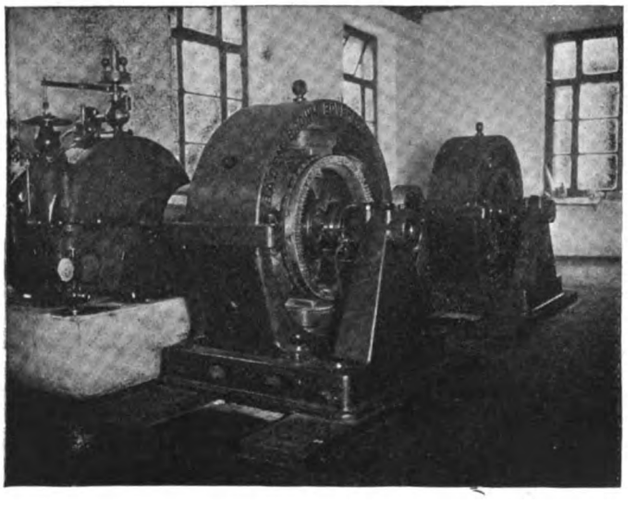


FIG. 5.—THE GENERATORS.



FIG. 6.—TRAIN ON INCLINE.

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tacts, which are composed of two long cylinders of aluminum separated from each other by a piece of wood soaked in paraffine. The bow system of contact has been adopted in order to avoid the difficulties of construction with overhead frogs, which were not considered desirable with two

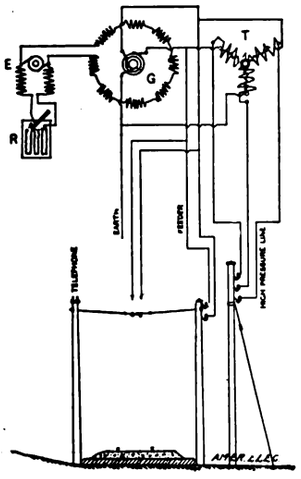



FIG. 7.—DIAGRAM OF GENERATING AND DISTRIBUTING CIRCUITS.

trolleys. The bows have given up to the present excellent satisfaction.

The locomotives are fitted with the following braking apparatus: first, ordinary brake shoes that operate on the four wheels; second, the motors working as generators when the current is reversed, the speed of the motors being constant whether they work as motors or generators; third, an emergency brake, operating simultaneously on the two grooved pulleys

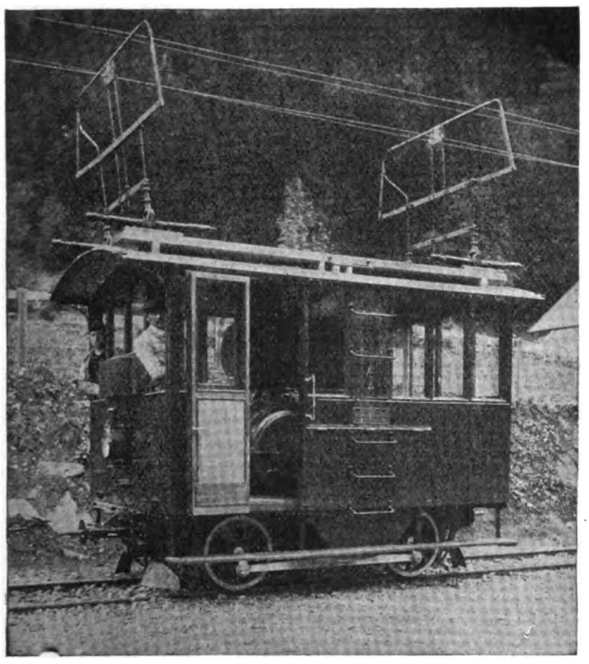


FIG. 10.—ONE OF THE LOCOMOTIVES.

or drums, of which one is mounted on the shaft of the motor and the other on the counter-shaft placed between the motors and the axles. These two brakes are connected mechanically together in such a way that the pressure divides itself uniformly on the two axles. When the eight brake shoes are applied a pressure is brought to bear against the grooved pulleys at the same time. The rack brake is operated in two different ways, by hand and automatically. To secure this a speed governor is used, which puts the brake in operation when the speed exceeds the normal. Moreover,

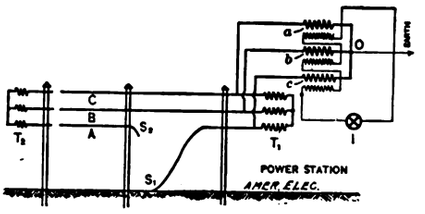



FIG. 8.—DEVICE TO DETECT BREAKAGE OF A LINE WIRE.

when the main switch is opened the brakes are automatically set.

The motor cars at present are five in number, and have a length of 46 ft. They are mounted on two trucks and divided into six compartments, not counting the compartment for baggage placed at the end of the car. The number of seats varies from 44 to 48. The two platforms are inclosed by a vestibule, the windows of which can be lowered at pleasure. The forward platform is reserved for the motorman, who has at hand the following apparatus for controlling the speed: a switch, a lever for throwing in the resistance of the diverter, and a hand brake. The approach of the car is signaled by means of a horn, and the car carries a small, primary battery, so that the conductor, who is on the rear platform, can signal to the motorman on the front platform.

The two motors are carried on the two axles of the same truck; they are 35 h.p. each with six poles, revolve at 480 r.p.m., and drive the axle by gearing. The free swivel truck is furnished on one axle with a toothed gear emerging in the rack and arranged to be braked by means of an emergency brake carried on the rear platform of the car. The efficiency of the motors at full load is 80 per cent, including the gears.

The regulating resistance, which is thrown in the induced circuit of the motors, is carried on the roof of the car, and inclosed in a water-tight case. The electric equipment of the cars is completed by fusible plugs and lightning arresters, as well as lamps for the general lighting of the interior of the car, and two signal lamps carried regularly on the head.

An interesting feature of this installation is the method of braking. When a train descends the grade of 25 per cent the motors are connected to the line as generators and send power into the line. This power is utilized in part by the other cars on the section, but as the amount of power produced in descending this steep grade is generally greater than the consumption of the other trains, the surplus has to be absorbed in some other way. Consequently at the central station there has been installed a water rheostat (Fig. 9) consisting of three rails laid in the discharge canal from the turbines. The distance between these rails and their length has been so adjusted as to permit their absorption of from 140 to 240 h.p. When a train starts to descend the steep grade the central station is advised of the fact by telephone, and the engineer at the central station throws in the water rheostat by means of two special switches. The system, although somewhat primitive, has given excellent results so far.

Another interesting feature is the device intended to prevent accidents from the breakage of the wires of the 5000-volt circuit. Referring to Fig. 8, the primary coils, a, b and c, of the three small transformers, are connected to three wires of the high-tension circuit at the points where

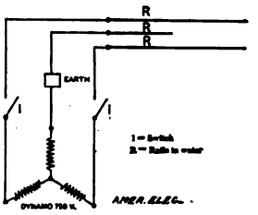



FIG. 9.—WATER RHEOSTAT.

they leave the station, and possess a common point O, which is led to earth. The secondary currents of these three transformers are connected in series to a single circuit, in which also is connected the apparatus which will produce the interruption of the primary circuit at the moment designed. The secondary e.m.f. of these transformers is 50 volts. The automatic circuit breaker in the circuit at I is an arc lamp.

When there is nothing abnormal in the circuit—that is to say, when there is no broken wire, there is an equilibrium of the entire system, and the secondary coils of the three transformers are not traversed by any current. When, on the other hand, any one of the three wires is broken, the equilibrium is interrupted. The unbalancing causes the secondary coils to be excited, and the current circulates so that the moment the carbons light they interrupt the exciting circuit of the generators. The tests made with this apparatus have consisted in letting a wire of the transmission circuit fall to the ground, and have shown that the interruption of the exciting circuit of the generators is produced in a length of time varying from four to seven seconds. The effect is then not absolutely instantaneous, but it would not be difficult to increase sensibly the rapidity of its operation, for example, by substituting for the arc lamp a circuit breaker which would open the circuit almost instantaneously.

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## FIELD WINDINGS OF DYNAMOS.

BY PROF. ARTHUR L. RICE.

The ordinary method of generating voltage in a dynamo is by moving a series of wires, which are wound on the armature core and connected in series, in a strong magnetic field. In order to denote the condition of the space in which there exists a magnetic field and to be able to discuss different intensities, the convention has been adopted of considering that such space is filled with magnetic lines or lines of magnetic force, and the intensity of the field is represented by the number of such lines which are supposed to exist per square inch. The magnetic field (or the lines) may be confined to an iron circuit in something the same way that a current is confined to an electric circuit; also the iron offers some opposition to the establishment of a magnetic field as does a conductor to an electric current. The great difference comes in the fact that all substances except iron and steel oppose very strongly the setting up of magnetism through them, but do not entirely prevent it; while all metals and some liquids are more or less good conductors, but substances such as mica, wood, rubber, cotton, porcelain and glass, known as insulators, will entirely prevent flow of current through them.

The non-magnetic materials when present in a magnetic circuit have the same

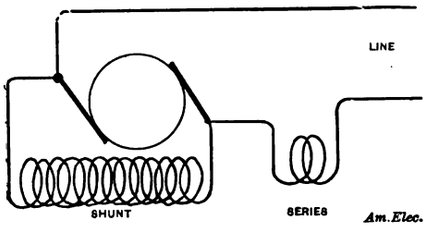



FIG. 1.—SHORT SHUNT CONNECTION.

relation to it that high resistance conductors have to an electric circuit; that is, they require a large force to establish magnetism through them, but do not prevent its establishment.

In the magnetic circuit of a dynamo there are included the cores of the field spools, the yoke joining them, the core of the armature and the air space, called the "gap," between the armature core and the pole faces. All parts are of iron or steel except the gaps, and hence require a comparatively small magneto-motive force to set up magnetism through them. The amount of magneto-motive force required in the iron parts depends on the strength of the magnetism which it is desired to set up; at high densities, such as are often used in the teeth of a toothed armature core, this may become considerable, but will seldom compare with the force needed to set up magnetism of the same density through an equal length of air.

The use of the field winding is to establish through the magnetic circuit of the dynamo, and especially through that portion in which the armature conductors revolve, the strong field needed for the generation of e.m.f. The magneto-motive force needed to set up this field is usually expressed in ampere turns; that is, in the turns of wire times the current flowing. The m.m.f. needed may be gotten by using many turns of wire and small current, or fewer turns and larger current. The more turns the greater will be the cost for copper; the greater the current, the larger will be the heat loss, and a limit to choice in this direction is set by the allowable heating of the field coils. This will confine the shunt current to not over 5 per cent of the line current, the value generally being much lower than this, depending on the per cent of loss allowed in the field winding. When the number of ampere turns has been determined and the space allowable for the coil decided upon, so that the average length of a turn on the coil is known, the size of wire is determined by the following considerations:

The current in amperes through the coil will, by Ohm's law, be equal to the e.m.f. on the field coils divided by the resistance of the coils;

$$\text{amp.} = \frac{\text{E.M.F.}}{\text{Res. of field}};$$

the resistance of the fields = the resistance per 1000 ft. × the length in thousands; R field = R per 1000 ft. ×

$$\frac{\text{length in ft.}}{1000.};$$

the length in ft. = the length of one turn × the number of turns. Combining these expressions,

$$\text{amp.} = \frac{\text{E. M. F.}}{\text{R per 1000 ft.} \times \frac{\text{length of 1 turn} \times \text{turns}}{1000}}$$

or the Res. per 1000 ft. =

$$\frac{\text{E.M.F.} \times 1000}{\text{amp. turns} \times \text{length one turn in ft.}}$$

The e.m.f. used should be about 25 per cent less than that of the machine to allow for regulation by the rheostat. From the resistance per 1000 ft. the size of wire may be determined from a wire table.

To decide whether the proposed winding is allowable, it is necessary to test if the rise in temperature which will follow its use is safe for the insulation. The rise usually considered safe is 80 degrees F., and there will be a rise of 99 degs. for each watt loss in heating of the field coils, which has to be radiated from a square in. of surface; that is, watts per sq. in × 99 = rise in temp. in degs. F. The watts allowable per sq. in. will then be,

$$\frac{80}{99} = 0.81$$

and the coil must be tested for this value. For good economy the resistance of the shunt must never be less than 300, and is better made 1000 times the armature resistance.

In determining the shunt winding, the flux to be established is that needed to establish the e.m.f. when there is no load on the machine. When current is flowing through the armature there is a tendency to demagnetize the fields, and also the e.m.f. at the machine terminals is less because of the drop in the armature due to its resistance. Both these effects increase as the line current increases, and therefore may be counterbalanced by the use of the line current carried around the field coils a number of times so that the back m.m.f. of the armature current is overcome and the magnetic field strengthened sufficiently to cause the e.m.f to rise as much as it will be cut down by the drop in the armature. By increasing the number of turns in the coil which carries line current,—which is in series with the line and is the "series" or "compound" coil,—the e.m.f. at the terminals of the machine may be made to rise as the current flowing in the line increases, and thus the dynamo may be over-compounded for the drop in the line or the feeders. It is difficult to compute accurately before the machine is wound exactly the number of series turns needed for any given compounding; in order to avoid rewinding, it is customary to put on a considerable number more turns than would probably be needed and to shunt part of the current by a piece of german silver or iron across the terminals of the series coil. The resistance of this shunt can be adjusted to give any desired value of compounding. The process of computation of the ampere turns needed for the shunt and series coils is being given in "Practical Lessons in Electricity," so need not be taken up here.

If it is desired to compound a dynamo after it is built, the number of series turns needed can be gotten as follows. Run the machine at no load and measure the cur-

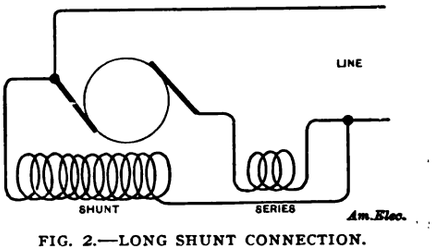



FIG. 2.—LONG SHUNT CONNECTION.

rent needed in the fields to bring it up to and adjust the field regulator until the voltage is at the required value. (If the machine is to be even compounded, this will be the same as the e.m.f. at no load; if overcompounded, it will be larger by the amount of the overcompounding.) Measure the field current again. The difference in these two readings of field current times the number of turns on the field coils will give the ampere turns needed in the compound coil; this value divided by the current in the series coil will give the number of turns needed. In the "short shunt" connection, Fig. 1, the shunt coil is connected directly to the brushes so that the shunt current does not go through the series coil; the "long shunt," Fig. 2, has the shunt connected across both armature and series coil, and the series coil does carry the shunt current. The former method requires a few more turns in the series coil to make up for the less amount of current. The size of wire to be used on the series coil is determined by the amount of heating permissible. In general its resistance should not be more than the resistance of the armature, and it is better kept below

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two-thirds of this value. This is a matter of efficiency of the machine, and any size of wire larger than that thus indicated may be used, but will increase the weight of copper on the machine and therefore the cost.

The shunt winding is generally made of a single cotton covered wire wound on the end of the spool next the yoke; it has a great many turns, high resistance, and uses only a small current. Leads of flexible cable are joined to the wire and brought out to make connections from spool to spool and to terminals.

If the shunt current of a 10-kw. machine which runs at 125 volts is to be 2.5 per cent. of the total current, it will be

$$\frac{10000 \times .025}{125} = 2 \text{ amperes.}$$

The resistance would then be, allowing 25 per cent of the voltage for regulation,

$$\frac{125 \times .75}{2} = 47 \text{ ohms.}$$

By the same process, the resistance for the shunt of a 50-kw. machine would be 9.4 ohms, but as the output increases the field loss allowed generally decreases, so that at 50 kw. it would be about 1.5 per cent and the resistance would be about 15.6 ohms. For some examples of two-pole commercial machines the resistances are, for the 10-kw., 53.8 ohms, and for the 50-kw., 12.4 ohms.

The series coil is wound up of copper strip, flexible cable or large wire, depending on the size of the machine. It is generally put on the end of the spool next the armature so that it will have as great an effect as possible on the magnetism in the air gap. The terminals are brought out as bars or as heavy flexible cable. Usually all the shunt coils on a dynamo are joined in series, and the compound coils are all joined in series. This is more likely to give the same degree of magnetization in all the poles than any other method of connection.

For the series coils of the previously considered machines, the resistances at two-thirds of the armature resistance would be .0284 ohms for the 10-kw. and .006 ohms for the 50-kw. The actual resistance of the compound coils on the machines cited are .015 ohms for the 10-kw. and .0014 ohms for the 50-kw. The total field loss in watts for the 10-kw. would be about 260, or 2.6 per cent of the output; for the 50-kw. the loss would be 932 watts, or about 1.9 per cent of the output. The resistances and field loss will be about the same for all well-designed machines of the same output regardless of the type. The resistances of the fields will increase in direct proportion to the square of the voltage; then the field loss which equals

$$\frac{E^2}{R}$$

will, if the voltage be doubled, be

$$\frac{(2E)^2}{4R} = \frac{4E^2}{4R} = \frac{E^2}{R}$$

the same as before. There will be twice as many turns of wire with half as large cross-section.

The relation between the ampere-turns on the shunt and series fields is not very exact, but may be averaged roughly as about 2 to 1. The accompanying table gives the resistances and losses of 125-volt direct-current dynamos, values being taken from the average of a number of tests and being about what would be found in any of the medium speed machines on the market.

The large per cent loss in the shunt field of the 50-kw. machine is due to the considerable rheostat resistance needed to hold the voltage down; the heat generated in the rheostat is wasted. The values agree fairly well with the table above given by D. C. Jackson in his "Text Book of Electro-Magnetism" for average losses of a dynamo:

TABLE II. PERCENTAGE LOSSES.

| OUTPUT. K. W. | Total Field Loss, Per Cent | Armature Loss, Per Cent. |
|---|---|---|
| 10 | 3.6 | 3.4 |
| 20 | 2.8 | 2.7 |
| 30 | 2.3 | 2.4 |
| 50 | 1.7 | 2.2 |
| 100 | 1.1 | 2.0 |

TABLE I.

| OUTPUT K. W. | RESISTANCE AT 60° F. | | | HEAT LOSS. | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | SHUNT AND RHEOSTAT. | | SERIES. | | ARMATURE. | | TOTAL FIELD. | | FIELD AND ARMATURE. | |
| | Shunt Ohms. | Series Ohms. | Arma. Ohms. | Watts. | Per Cent. | Watts. | Per Cent. | Watts. | Per Cent. | Watts. | Per Cent. | Watts. | Per Cent. |
| 10 | 53.8 | .0149 | .0425 | 216 | 2.16 | 91.5 | 0.92 | 272 | 2.72 | 307.5 | 3.08 | 579.5 | 5.80 |
| 20 | 39.0 | .0091 | .0200 | 287 | 1.44 | 233. | 1.17 | 518 | 2.57 | 520. | 2.60 | 1038. | 5.16 |
| 30 | 28.0 | .0029 | .0108 | 381 | 1.27 | 167. | 0.56 | 620 | 2.07 | 548. | 1.83 | 1168. | 3.89 |
| 50 | 12.4 | .0014 | .0070 | 688 | 1.37 | 224. | 0.45 | 1120 | 2.24 | 912. | 1.82 | 2032. | 4.06 |

# Improvement of the Steam Engine.

## IMPROVEMENT IN THE ECOMONY OF THE STEAM ENGINE.

BY PROF. W. F. DURAND.

The aim of those concerned with the improvement of the steam engine as a prime mover is to decrease the cost of operation per unit of delivered power. This cost first and last is dependent on many conditions, chief among which are: (1) The cost of coal. (2) The efficiency of the boiler or the cost of steam in pounds of coal. (3) The thermal efficiency of the engine or the cost of the indicated horse power in terms of the steam, or, more properly, in terms of the heat of which the steam is simply the carrier. (4) The mechanical efficiency, or the fraction of the indicated power which can be delivered to a driven machine, such, for example, as an electric generator. With 1 and 2 we are not at present concerned. They relate fundamentally to the boiler part of the power plant. We are here concerned with the economy of the steam engine alone, and this depends simply on 3 and 4, the thermal and mechanical efficiencies of the engine.

Regarding the latter, it may be said in brief that advance in this direction must come in improved methods of mechanical design and construction. Much in this way has been accomplished in the past few years. The total loss due to mechanical inefficiency and absorbed by frictional resistances is probably not over 8 to 10 per cent in good practice at the present time. With further advances toward ideal mechanical perfection, it becomes more and more difficult to make additional steps, and it is probable that with present types of engines, but little more can be gained in mechanical efficiency.

Turning now to 3, the subject proper of the present article, we shall discuss the various conditions upon which depend the thermal efficiency of the steam engine.

A discussion of the fundamental principles relating to the efficiency of the steam engine will be found in the AMERICAN ELECTRICIAN for August, 1896, page 117. To sum up briefly these fundamental points, it appears from the science of thermodynamics that the ideal efficiency of any heat engine is expressed by the difference in the temperatures between which the engine works, divided by the higher temperature measured from the absolute zero. In symbols this becomes:

$$e = \frac{t_2 - t_1}{460.7 + t_2}$$

where $e$ is efficiency and $t_2$ and $t_1$ are the higher and lower temperatures between which the engine works. The conditions to be fulfilled in order that this efficiency may be attained are as follows: (1) The absorption of heat by the working substance must all take place at the constant upper temperature, $t_2$. (2) The rejection of heat must all take place at the constant lower temperature, $t_1$. (3) The passage of the working substance from the higher temperature, $t_2$, to the lower temperature, $t_1$,

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must be by means of an expansion in which no heat is either absorbed or rejected. (4) The passage from the lower temperature, $t_1$, to the higher temperature, $t_2$, must be by means of a compression in which no heat is either absorbed or rejected. Such a series of operations constitutes the so-called *Carnot* cycle, and stands as the highest ideal toward which the actual engine cycle should be made to approach as closely as possible. In practice no one of these conditions is actually fulfilled, and the efficiency attained is hence only a fraction of the ideal. This fraction or relative efficiency may vary from about 75 per cent downward as the conditions for the ideal cycle are more and more widely departed from.

It will be plain now that improvement in the steam engine may proceed along two lines. (1) An attempt to raise the ideal efficiency, expecting that the actual efficiency will follow upward in proportionate degree. (2) An attempt to approach more nearly to the ideal conditions and thus to realize a larger fraction of the ideal efficiency as fixed by the given temperature limits. All methods for the improvement of the steam engine may be grouped under one or the other, or both of these headings. Let us examine in order the more important.

Reference to the value of $e$ above shows that improvement in the ideal efficiency may be realized by relatively increasing the numerator of the fraction. This may be brought about by either lowering the lower temperature, $t_1$, or raising the higher, $t_2$, or both, thus in any case increasing the temperature range. Practically the lower temperature cannot be much lowered. In a condensing engine it is the temperature of the condenser, and it is not practicable to reduce this much below 100 to 120 F. It only remains then to raise $t_2$, the upper temperature, or the temperature of the steam as it enters the cylinder. This may be done by using higher steam pressure or by superheating, or both. In the former the pressure is raised, but without attempting to superheat, so that pressure and temperature increase together according to the law for saturated steam. In the latter the steam is heated out of immediate contact with water, and thus becomes superheated. In such case the increase of pressure relative to temperature is less rapid than for saturated steam, so that the temperature is higher than for saturated steam having the same pressure or the pressure is lower than for saturated steam having the same temperature.

Both of these methods of increasing efficiency are attracting present attention from those concerned with these problems. It may be noted, however, that with superheated steam, unless the degree of superheat is considerable, it will all disappear on the entrance of the steam into the cylinder, due to the absorption of the heat by the relatively cold walls, as discussed further at a later point. It will result in such case that the actual temperature range will not be increased, though a saving will be effected as will be seen later under another head.

Let us now turn to the means available for improving the process by means of which the heat of the steam is transformed into mechanical work. We must first note the more important ways in which the actual process departs from the ideal as already described. It will be remembered that in the ideal cycle the elevation of temperature is obtained wholly by a compression without loss or gain of heat, and that all heat received is taken in at constant temperature during the next stage of the process. In the actual process the water is fed into the boiler at a relatively low temperature, which is gradually raised by the addition of heat until the temperature of boiling is reached. Then during transformation into vapor the heat is added at constant temperature. Again, in the ideal process the expansion should be without loss or receipt of heat from without. This is not fulfilled, because the walls of the cylinder absorb heat from the steam during admission, and then give it back to a greater or less extent during expansion.

Again, in the ideal process the heat is all given up at the constant lower temperature of the cycle. This is not fulfilled in the actual process, for expansion is rarely down to the back pressure, and the heat is therefore given up at a range of temperature extending from that at the end of expansion down to the final exhaust temperature. The compression is furthermore usually incomplete, and in any event it does not deal with the actual working substance which is rejected from the cylinder and sent to the boiler as feed water.

In addition to the losses due to these various irregularities of the cycle there is a constant loss of heat by radiation from the outer surface of the cylinder and piston rod, and by conduction through the frame, bed-plate, etc.

Then again, parallel with the cycle through which the steam passes, there is also a cycle through which the metal of the cylinder passes, resulting in a transfer of heat from the boiler to the condenser without doing useful work. This operation is as follows: At the instant the steam valve opens the steam rushes in, to find itself in contact with surfaces which have but recently been exposed to the influence of the condenser or the external air. They are therefore at a lower temperature than the steam, and hence absorb heat from it, resulting in its partial condensation.

This absorption of heat has been already referred to above in speaking of the irregularities of the cycle, and, as there stated, a part of the heat so absorbed will be given back during expansion. As noted, this results in a loss by itself, but by far the greater part of this heat is not returned until the exhaust period. This means that it is carried by the exhaust steam to the condenser without doing useful work. It thus appears that this action of the walls of the cylinder is equivalent to a means whereby a part of the heat short circuits past the work producing cycle in the cylinder, and thus escapes. The heat, which thus avoids the regular cycle, appears as an expense, but with no corresponding useful result.

We may here quote from an earlier communication by the author on this same subject.*

"This action of the walls of a steam cylinder depends on their capacity, when at a lower temperature, for absorbing heat from the steam during admission and for giving it up when at a higher temperature, as during exhaust. The amount of such action depends therefore on the range of temperature between admission and exhaust, and on the particular readiness with which the walls absorb and reject heat according as they are cooler or hotter than their surroundings. There are, therefore, two distinct features to be considered—the range of temperature and the characteristic readiness of absorption and emission. Now it seems to be the case that once the walls of the cylinder become wetted or covered with a film of moisture, the absorption and emission of heat into and from the metal proceed with much greater readiness than when they are dry. In other words, the passage of heat between metal with a moistened surface and moist steam is much more rapid than between the same metal with a dry surface and dry or superheated steam. In the ordinary steam engine we have, therefore, an action of the walls due to the range of temperature employed, and to the natural capacity of cast iron to absorb and emit heat from and to steam, greatly augmented by the presence of a more or less complete film or layer of water over the surface, arising from the condensation of the first entering saturated steam."

This action of the walls producing what is termed *initial condensation* is one of the most serious causes of loss in efficiency, and one which has long attracted the attention of those concerned with the improvement of steam engine economy. Improvement may be sought in two directions. (1) In the use of a material for cylinders which shall reduce the fundamental action of the walls as above described. (2) By preventing the formation of the initial layer of moisture on the inner walls and thus avoiding the multiplied amount of action which seems to accompany such formation.

For reducing the fundamental action of the walls several methods have been attempted. A material is required which shall be slow to absorb heat and equally slow to give it out. Various ways of treating the inner surfaces of cylinders so that they should less readily absorb and emit heat have been proposed, and some have been tried in practice. The results, however, have been comparatively small in amount, and while the engineer should always hold this in mind as a possible means of increasing economy, there has not, as yet, been found a practicable and efficient mode of carrying it out.

In the following number we shall discuss the more important methods available for decreasing the amount of water formed on the cylinder wall during the cycle. This will bring us to the questions which are more particularly attracting present attention from those interested in the economy of the steam engine.

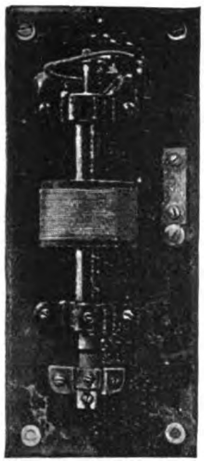
* American Electrician, Apr., 1898, p. 161.

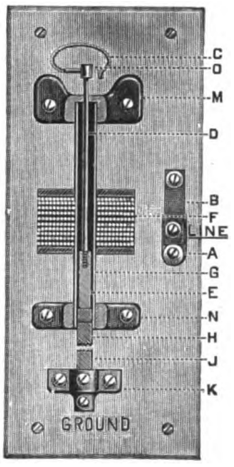
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## TYPES OF AMERICAN LIGHTNING ARRESTERS.

BY H. E. RAYMOND.

Among lightning arresters depending upon a movable mechanism for arc destroying devices, the Garton type occupies a prominent position. This arrester, the station form of which is shown in Fig. 1 and the cross-sectional view in Fig. 2, is designed for operation on both direct and alternating currents of any frequency and voltage. Standard sizes include those for use on circuits of from 52 to 2000 volts.






FIGS. 1 AND 2.—GARTON STATION ARRESTER.

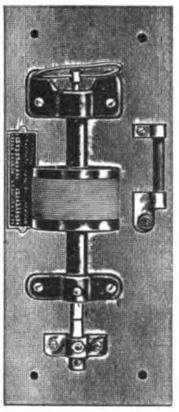


FIG. 3.—GARTON RAILWAY STATION ARRESTER.



FIG. 5.—GARTON CAR ARRESTER.

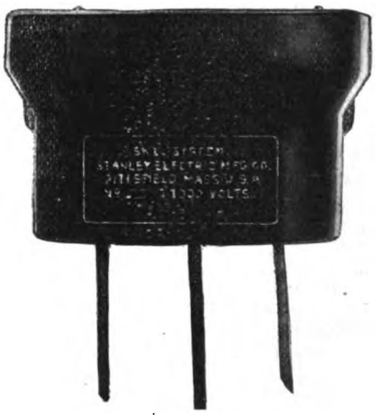


FIG. 7.—S. K. C. ARRESTER FOR LINE USE.

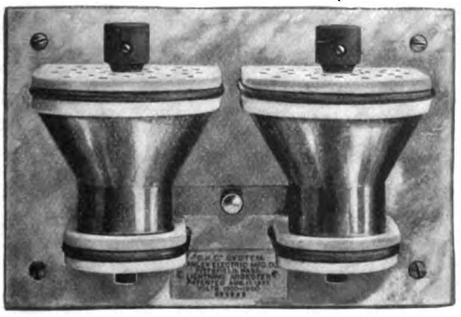


FIG. 6.—S. K. C. STATION ARRESTER.



FIG. 8.—PARTS OF S. K. C. ARRESTER.

In Fig. 3 is shown the street railway station form, which differs from the ordinary station arrester in the resistance of the graphite, and in the fact that the coil is normally rests on the top of the upper discharger, is drawn up by the magnetism of the solenoid, and the arc broken in the tube in which it forms.

The action of the arrester is such that a discharge coming from the line enters the arrester at the lower end of the graphite in shunt with part of the resistance only. The pole arrester, Fig. 4, is of similar type, inclosed in a weather-proof box of wood or iron. The car arrester, Fig. 5, is also similar, and is placed in a case provided with flanges, in such a manner that the lower end may project below the car

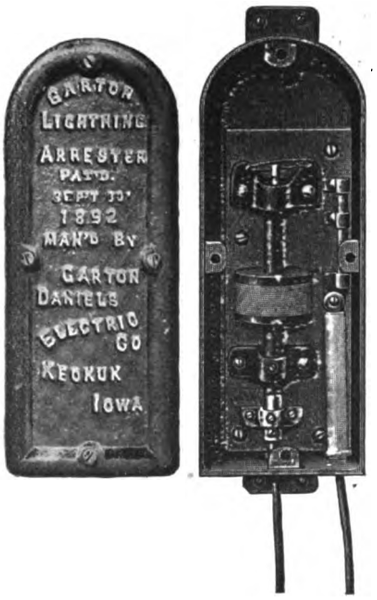



FIG. 4.—GARTON POLE ARRESTER.

floor and reduce the space required. The Garton-Daniels Company recommend the use of one arrester on each wire where it enters the building. They also employ choke coils made up in a convenient form.

The S. K. C. arrester, the open form of which, Fig. 6, is designed for station use, is intended to be used on alternating current circuits only. The inclosed or outdoor form, Fig. 7, is identical with the station type except that it is placed in an iron box. The arrester consists of two nests of tunnel-shaped concentric brass castings surrounding a central cylinder. The diverging portions are placed at the top, and at both top and bottom are porcelain plates grooved to fit the brasses, or cylinders, and hold them in certain relative position. To the innermost cylinders the line is electrically connected. The outer cylinders of each pair are joined by a metal strip, to which in the double pole form the ground wires are connected. These dischargers are held by the grooves in the porcelain, Fig. 8, in such relative positions that the parallel portions shall be 1-16 in. apart. The upper cone-shaped or flaring portions are made so that the angle of divergence from the perpendicular increases toward the outer discharger. By

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this means it is claimed a natural sparking distance is obtained, and should the arc form, it would travel upward to where the terminals are further apart. This increased distance, together with the greater surface and the upward currents of air, will tend to break the arc.

There are three gaps for every 1000 volts, each gap being 1-16 in. long. One-half a double pole arrester contains 3-16 in. gap. This distance requires, at commercial frequencies, 5000 volts to jump it, but it is

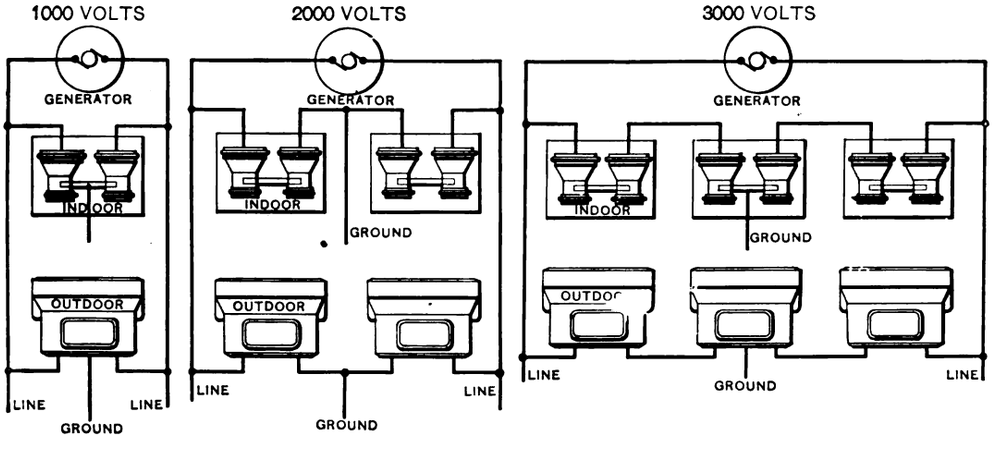



FIG. 9.—CONNECTIONS, S. K. C. ARRESTER, ON SINGLE PHASE.

claimed that at the frequency of lightning less than one-half will bridge the gap. This very considerable air space is considered an advantage on account of this very surprising phenomenon, for the space allowed would naturally permit of a certain rupture of the arc and yet at high static charge frequencies be of low discharging potential. The composition of the dischargers

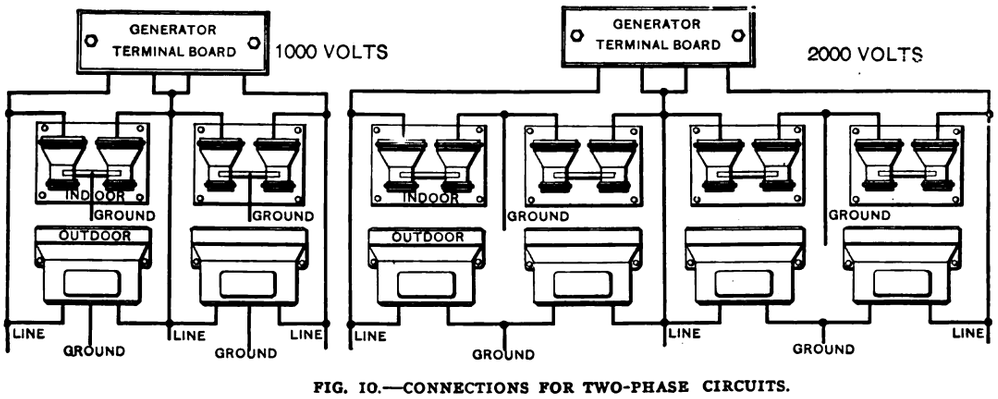



FIG. 10.—CONNECTIONS FOR TWO-PHASE CIRCUITS.

is not stated, but is presumably of some form of cast brass.

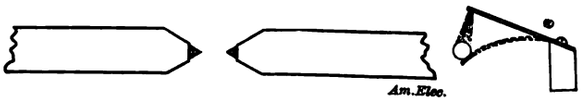
The arrester is made in one form only, the out-door type being identical with the station type, and simply placed in a weather-proof box. The standard unit is called 1000 volts double pole. For voltages higher than this they are used in combinations of single and double pole, so arranged that there will be three gaps for each 1000 volts. Fig. 9 illustrates the connections for single phase work to 3000 volts, and Fig. 10, the method of installing on two-phase three-wire, three-phase, etc.

## ARCS AND NON-ARCING METALS.

BY GEORGE T. HANCHETT.

If we place two pieces of metal in intimate contact with each other and pass through the joint an electric current, we shall find that on separating the joint an arc occurs, the magnitude of which seems to depend upon a number of causes. The higher the voltage and the greater the volume of current, the more intense is the arc. If the voltage is the predominant feature, the arc will be considerably attenuated, but if, on the other hand, the current is the large quantity and the voltage is small, the arc will also be very small.

It is further a fact that if the circuit is broken quickly, the arc will be less intense and elongated than if it is broken slowly. Another feature which may not be unfamiliar to many is, that if the terminals of the circuit are separated from point contact, such as is shown in Fig. 1, the arc or




FIGS. 1 AND 2.—TYPES OF CONTACTS.

spark is very much less than is the case of wipe contact, such as is shown in Fig. 2. The first method of breaking circuit is familiar in telegraph relays. The second appears in pendant gas burners, and it will at once be remembered that the facts just cited obtain, although the first thought would seem to be that a wipe spring contact would break so much more rapidly than a point contact that the arc or spark would be correspondingly reduced. It is also a fact that two terminals connected to a circuit which will maintain a very long and intense arc may be approached to within a few one-hundredths of an inch, and, unless contact is made, no arc will be formed.

These phenomena which have just been cited, most of which are familiar to everyone, if carefully considered seem to furnish a reasonable basis for some most interesting conclusions which it is the purpose of this article to set forth

If we are to determine the exact method by which an arc starts, we must consider the condition of the two surfaces between which it is formed at the moment of their separation. The fact that two surfaces of widely different potentials can be approached within a minute distance without forming an arc, shows conclusively that with the ordinary conditions which obtain on commercial circuits there is no static or jumping effect which is measurable.

Two surfaces are pressed together into close contact, and as they are separated the elasticity of the materials comes into play and the area of contact grows less and less, in precisely the same way as if two rubber spheres were pressed together and separated. Presently the narrow isthmus of metal through which the current flows becomes so small that it is heated red hot. It becomes smaller still and is vaporized, bridging the gap with vapors of moderately high resistance. If the resistance of these vapors is the largest part of the total resistance of the circuit there will be practically no arc, for as the area of contact diminishes the current diminishes also; but if, on the other hand, it is a comparatively small part of the resistance of circuit, and a well sustained voltage is at hand to keep up the magnitude of the current, the over heating just described will occur and an arc will follow, for current will be forced through the comparatively high resistance formed by the vaporized metals. The $C^2R$ loss will be very great and appear in heat at that point, which will vaporize more of the terminals and assist in the formation of the arc. If the surfaces are rapidly separated, the resistance of the arc will become so great that the current will fail to maintain its value and the arc will break. With arc machines the voltage is sufficient to overcome the resistance of a very long train of vaporized metal.

If this is true, and the writer believes that it is the generally accepted theory, it follows that if a metal of zero restivity could be provided it would be a non-arcing metal, for the reason that no matter how attenuated its contact might be the resistance thereof would be zero, and hence the final point of contact would not be heated at all and the arc would not start.

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It also follows that if a metal was provided that is absolutely non-elastic, and if two surfaces of this metal were prepared, absolutely plane, and pressed together into intimate contact, and then separated in a line at exactly right angles to the contact surface, that no arc would follow, no matter what the current or voltage, for the reason that there would be only two resistances in the joint during the operation, namely, the resistance of the joint pressed together, and the practically infinite resistance of the short air gap. The isthmus effect, if such it can be called, upon which the arc depends for its formation, would not occur. Of course, the conditions must be such that the voltage cannot produce an electrostatic jumping. This theory offers an explanation of the point contact phenomena already referred to.

A non-arcing metal should, of course, have as high a melting point as possible, for in this way, even though an attenuated contact may become gradually overheated, the amount that is volatilized will not afford as good a nucleus for the formation of an arc as will be the case with the larger volume of conducting vapor that the same heat would form from a more fusible metal.

From the foregoing we can lay down the following specifications for a non-arcing metal. First, its refractory character should be very high. If it were absolutely infusible there would be no arc. Second, its resistivity must be very low. If it had no resistance there would be no arc. It would seem, therefore, that it is advisable to experiment with a highly infusible metal, such as platinum or iridium, and endeavor to make an alloy of low resistivity and at the same time retaining the refractory properties of the initial components.

Carbon, which is the least fusible of all conducting substances, unfortunately cannot be prepared in surfaces which will make intimate contact with each other. The contact is always granular and the little particles between the contact surfaces always become volatilized and form an arc. Moreover, its resistance is very high. In spite of these defects, carbon is one of the best non-arcing substances that we have, due to its very high refractory powers, and as such is used for auxiliary contacts or whenever a circuit is to be broken repeatedly.

Metal which, when vaporized, forms an exceedingly high resistance, will also be non-arcing, and the many metals have been made claiming to possess the non-arcing property, if they have possessed any characteristic at all that would logically conduce to this result, depend upon this principle.

The technical press has been rife with discussions as to whether there was any such thing as cooling effect; that is to say, whether the presence of a large volume of metal in the immediate proximity of an arc tended to reduce its intensity and cool it out, as it were. It seems to the writer that the arc occurring between large terminals would be less than that occurring between small ones carrying the same current at the same voltage, for the reason that under the given conditions it would be impossible to volatilize so large a volume of metal in the case of the large terminals as in that of small ones. It is evident that with large terminals the "isthmus" of metal between the two separating surfaces would be very much smaller before the vaporizing point was reached, because the heat would be more rapidly conducted away. As to the possibility of cooling out a well established arc, the writer's experience has seemed to show that the size of the terminals is immaterial.

Methods of avoiding arcs are numerous and ingenious, and all of them are based directly upon the principle of the formation of the arc, although the writer is not aware that they were applied with a predetermined notion, or for any other reason than that they were found to be effective. The simplest of these is to blow out the arc, either by means of an air blast or a magnet. The air blast blows away the conducting vapor and breaks the circuit. The magnet repels the current carrying conductor, which is, of course, the vapor, and produces practically the same result.

Another popular way to avoid the arc is to break it up into many parts by a number of simultaneous breaks in series. This practically multiplies the rapidity with which the circuit is broken by the number of breaks, and in addition subdivides the heating energy superinduced by the breaking of the circuit into many small portions, all of which are collectively unable to volatilize as much metal as if they were concentrated at a single point. In this way one large arc is exchanged for a number of smaller ones, each of which is moderately harmless.

Still another way to avoid arcs is to shunt the point where the circuit is broken by means of a high resistance. This is effective only in cases of circuits where the sparking current is due to an inductive discharge. If applied to an ordinary non-inductive break it would simply reduce the arc in proportion to the current that it deflected from the main switch jaws. If the resistance that is placed in multiple with the arc be low, it will deflect considerable current from the main switch jaws and largely reduce the arc occurring there, but in such cases it will be usually necessary to break the auxiliary circuit also.

This principle is adapted to main circuits in which the copper contacts are reinforced by carbon. The copper contacts are supposed to carry the current, the carbon to take the arc. In order that the arcs shall come for the most part to the carbon circuit, its resistance must be extremely low.

Another method of transferring the arc applies in cases where the resistance of the contact is not material, and main switch and auxiliary break are arranged in series. In this combination the carbon contacts must open first in order to take the arc, whereas in parallel combination they are opened last.

# Alternating Current Motors.

## ALTERNATING CURRENT SYNCHRONOUS AND INDUCTION MOTORS.

BY ERNST JULIUS BERG.

Although during recent years a great variety of alternating current commutator motors, such as series motors, shunt motors and reaction motors have been built, their field for usefulness has been so limited, compared with synchronous motors and induction motors, that in this article attention will be confined solely to the latter.

### SYNCHRONOUS MOTORS.

By far the larger number of alternating current motors used at present are of the polyphase type. This type has many electrical advantages, such as higher efficiency, ability to start with considerable torque, and is commercially preferable on account of its lower cost. Single-phase synchronous motors are operated in very few places. They are, however, entirely feasible, even at 125 cycles, provided the rate of rotation of the generators is uniform; that is, provided the generators are belted to fair regulating engines or water wheels, or directly connected to engines of extremely close speed regulation.

As an interesting instance of such an installation may be mentioned the station of Chatham Electric Light Company, of New York, in which a smooth-core, high-frequency, single-phase alternator is run successfully as a synchronous motor from an iron-clad, high-frequency generator. This is not mentioned to show an ideal combination, but simply as indicating that, even under extreme conditions, high-frequency, single-phase, synchronous motors are feasible. Owing to their mechanical construction, smooth-core machines are not as feasible as iron-clad, since the winding is not as rigidly held, and therefore may strip off if the motor is thrown on to the line at the wrong time, or when a very large current would be taken.

Iron-clad synchronous motors run from iron-clad alternators should always be feasible under the assumption of fair speed regulation, as stated above.

Low-frequency synchronous motors are almost all of the polyphase type since, with the introduction of the lower frequency, polyphase systems, as a rule, were also adopted. An exception to this statement may be the monocyclic 60-cycle installations, of which there are a number in which synchronous motors are used.

Synchronous motors are of similar construction to generators. As a rule, they are not composite wound, but are separately excited. This construction is adopted chiefly for simplicity, and also because the field adjustment necessary to make a synchronous motor run non-inductively at all loads is very small—much less than that necessary in order to obtain constant po-

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tential from the same machine run as a generator of the same electrical output.

To illustrate this, in Figs. 1, 2 and 3 are given saturation, compounding curves and phase characteristic of a small three-phase synchronous motor.

It is interesting to note that in order to maintain constant potential at a certain load when this machine is run as generator, the field excitation is higher than that when giving the same output as a synchronous motor, so that, for instance, when operating it as generator at 110 volts, the no-load excitation is 1900 ampere-turns; with 105 amperes load, which corresponds to 20 kw. output, the field excitation is 2430 ampere-turns.

From the phase characteristic given in Fig. 3 it is seen that, for the same output as a motor, the excitation for non-inductive input to the synchronous motor is but 2150 ampere-turns.

The lower curve on Fig. 3 gives the phase characteristic at no load, and shows that the alternating current increases if the excitation is increased, or reduced, from the value which corresponds to the non-inductive position. With reduced excitation the synchronous motor is made to take lagging current, when increased, to take a leading current. The upper curve shows the same relation with full load on the machine.

From this, it is evident that to make the synchronous motor run at minimum current at all loads, its excitation should be slightly raised with the load. However, even should the excitation be left constant, the increase in current at full load would be extremely small, 1 or 2 per cent; thus, it would be unnecessary to change the excitation with the load in this particular synchronous motor, if it were not that other results were expected, such as compensation for lagging currents introduced by other apparatus in the system. Even should the field of the synchronous motor break—that is, the motor run without direct current field—it would still run and give its rated output. The alternating current taken by the motor would, however, increase, and if the motor had a long air-gap, this increase will be large, though small with a small air-gap.

It is readily possible to build a synchronous motor in which, if the field is broken, the full load current will only be increased 30 per cent, or thereabouts. The current taken by a synchronous motor without field excitation is, however, lagging, and thus its usefulness as a compensator in systems of induction motors and such apparatus, which also take lagging current, would be nullified.

The effect of this compensation of idle currents, or what is called phase control, by a synchronous motor, although frequently discussed, is rarely appreciated.

Assume a system in which the wattless component of current is as high as 30 or 40 per cent, and that this is to be compensated for by a synchronous motor of the same capacity as the other load on the system. The excitation of the synchronous motor has only to be increased by such an amount that the full-load current taken by the motor is increased 4½ per cent and 8 per cent, respectively, which would not materially affect its overload capacity; indeed, it is almost impossible to load a synchronous motor sufficiently high to stop it, provided that the voltage impressed upon the motor is constant and the power behind it stable.

Often synchronous motors are used to give a stable point of voltage in the receiving circuit. This is done by changing the excitation of the motor so that it is made to take leading or lagging currents which, going over a line of some self-induction or other reactances, causes the voltage to increase or decrease as the need may be. This arrangement gives a condition similar to that obtained if the synchronous motors were generators.

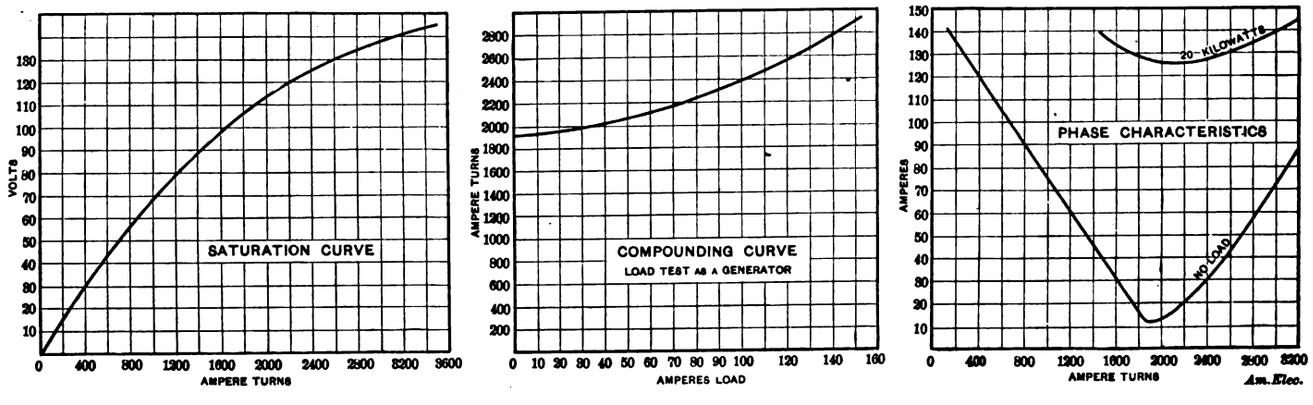
In starting, a polyphase synchronous motor can readily be designed so as to give full load torque. Its current at starting, however, is large, usually four or five times the full load current, and consequently it is not the best motor for conditions where good starting torque is required. When a synchronous motor is started, it is advantageous to reduce the voltage so as to limit the current. This reduction in voltage can be accomplished in several ways—for instance, by inserting resistance in the line, by inserting reactance in the line, or by compensators.

By the use of resistances, the starting current is lessened by consuming electromotive force, that is, by waste of power, and is, therefore, as a rule, not to be recommended. Reducing the current by means of reactances in series with the line accomplishes the result without loss of power, but introduces an extremely poor power factor in the starting moment; consequently, this method, as a rule, will have a bad effect on the generator by reducing its voltage and causing a general disturbance in the system. The last-mentioned arrangement of reducing the voltage by the use of compensators is the proper method, since the compensator acts as a transformer and the reduction in voltage is not followed by loss in power or by the introduction of large wattless currents. In other words, the volt-amperes input for a given starting torque is very much less in the last case.

At the moment of starting the synchronous motor acts more or less as a stationary transformer in which the armature winding is the primary and the field winding the secondary; therefore, since usually the field winding has very many more turns per pole than the armature winding, the electromotive force induced in the field spools is extremely high, and special precautions have to be taken to insure safety from burning out. This is done by open-circuiting the field windings in several places so as to leave only a few poles connected in series; also, by short circuiting the field winding, and, finally, by making the body of the field spools of rather heavy metal, so as to act as a short-circuited secondary at the moment of starting.

Depending upon which of these methods are used, the starting torque and the relation between the starting torque and the starting current changes. As a rule, when the field windings are left open-circuited, the most favorable starting condition is obtained; with the field winding short-circuited, the condition is poorest, although the safety factor is highest in this case. By using a low-resisting short circuit around the spools, a fair starting torque with a fair starting current is obtained, and this method is probably the best all around. When up to speed, the fields are excited in the usual way by direct current.

Although induction motors, as well as synchronous motors, are sensitive to the speed regulation of prime movers, there is no doubt that a synchronous motor requires a much closer speed regulation than induction motors. Therefore, before deciding upon the installation of synchronous motors, a thorough investigation of the prime mover has to be made. As a rule,




FIGS. 1, 2 AND 3.—CURVES OF THREE-PHASE SYNCHRONOUS MOTOR, 20 KW., 110-VOLTS.

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water power, which gives a uniform rate of rotation of the prime mover, does not offer any difficulties, but often steam engine driven alternators prohibit their use. This is frequently the case when the generator is direct connected to a slow speed engine; with belted generators difficulties are rarely experienced. The more poles a given alternator has, the the closer speed regulation of the engine is required. Indeed, the percentage speed variation permissible is indirectly proportional to the number of poles; therefore, very often low-frequency synchronous motor systems can be installed from steam engine driven alternators, whereas high-frequency systems would be prohibited.

It must finally be borne in mind that all generators feeding synchronous motors must be operated in parallel, since they will stop if the load is thrown off one generator to another without first having them in multiple.

In a concluding article the subjects of poly-phase and single-phase induction motors will be considered.

# Among our Foreign Contemporaries

Edited by CHARLES T. CHILD

**Calcium Carbide.**—At a recent meeting of the Polytechnic Society at Berlin, M. Nicolai read a paper on the manufacture of calcium carbide, from which the "Electrical Engineer" abstracts some interesting data. The author stated that the best proportions of mixture were 100 parts by weight of lime to 70 of coke. Lime averaging 99 per cent of calcium oxide and coke low in ash will produce almost pure carbide. The coke should not run higher in ash than 5 per cent. Charcoal proves unsuitable for the furnace process, but in the smelting machine invented by the author it can be used. In this machine the material to be smelted is compressed to a suitable depth on an electrical conductor, and the arc touches the compressed mass only at the moment of smelting. The burning of the carbon, or the carrying off of fine particles of lime, is impossible, because the hot gas developed escapes directly into the open air without coming in contact with the charge. In the manufacture of carbide care should be taken that the raw material is not burned by the hot gas, as is often the case in the electrical furnace. The raw material should be exposed to the electric arc only so long as is necessary for its conversion into carbide, and in this way the loss of material and of electric power may be reduced to a minimum.

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**Explosions of Fire Damp by Incandescent Elements.** — Notice has been taken in these columns in other issues, of the elaborate experimental work of MM. Couriot and Meunier upon the conditions of explosion of mixtures of fire damp and air, such as are met with in coal mines. Later researches made by these experimentalists have been presented to the Académie des Sciences, and have shown conclusively that an incandescent filament will not ignite this mixture, even in its most explosive proportions. The bulbs of incandescent lamps were filled with gas, and the lamps not only carried up to their customary incandescence, but forced far beyond it. The only result noticed was a decomposition of the gaseous mixture with the formation of carbonic oxide and water vapor. In this atmosphere, surrounding the filament, a break in the latter giving rise to a flash would not ignite the remaining gas; if, however, a spark, especially one due to a rupture of a current of one or more amperes, took place in the gas, its explosion was found to be practically certain.

Probably the whole of the results of this work may be summed up by the statement that electrical apparatus are absolutely safe in fiery mines if they can be guarded against the possibility of a spark or flash. The breaking of an incandescent lamp will not fire the most explosive mixture, but the snapping of a switch may very readily do so.

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**Home Made Fluorescent Screens.**—The (London) "Electrical Review" abstracts a communication in the "British and Colonial Druggist" describing simple fluorescent screens. The method of making the screen, as given by the author, is as follows: Take a plate of glass, say 6½ ins. x 8½ ins., and make a mat of stout paper, having an opening about 5 ins. to 7 ins. This mat is to be wetted with glycerine or gum-arabic mucilage and pasted over the plate, which is then to be covered with collodion, varnish, or mucilage containing a little glycerine. The powdered salt is then to be sprinkled quickly and evenly all over the surface. Calcium tungstate is recommended by the author as the best material, though he considers a salt of uranium (the particular salt not being specified) as giving excellent results.

If parchment, cardboard, ebonite or such material be used in place of the glass, one may put a coating on both sides, and in this way even up any inequalities of deposit. If glass is used, the coated side, which must face the tube (away from the observer), must be covered, over the layer of salt, with a piece of thin celluloid or opaque paper. When the platino-cyanides are used they should be mixed with varnish and spread on a glass or paper surface. The difficulty is to get an even coating, but a roller may be applied on any surface but glass, with satisfactory results. The author states that a vehicle of equal parts of paraffine and vaseline, melted together and containing the salt in the proportion of about one-quarter of an ounce for a screen of the size mentioned, gives most satisfactory results. It is applied while it is warm and sticky by means of a spatula. The trouble with this particular compound is that it is liable to melt and run in a warm atmosphere.

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**Electric Mountain Climbing.**—Some interesting figures with regard to the new Gornergrat Railway, in Switzerland, are given in "Le Journal des Transports." This railway was opened on Aug. 20, last, and is the highest railway in Europe now in operation. By means of electric traction the traveler is taken up to an altitude of 9810 ft., making this ascent from the Zermatt Hotel, itself at an altitude of about 5000 ft.

The object of building the road was to substitute a more rapid, economical and infinitely more convenient method of transit for the mules, which have been used from time immemorial for this purpose. It appears that a mule costs 15 francs, and the driver expects 2 francs, and that this power can only be used in going up the mountain, because it is more comfortable and convenient to walk down than to ride down on a mule sloping forward at an acute angle. The electric line charges 12 francs to go up the mountain, and 18 francs for the round trip, and takes less than one-third of the time occupied by the mule transit method. This railway will be remembered as one of the very few on which polyphase motors are used for traction purposes. Three-phase current generated from water-power from a neighboring stream is fed directly to two parallel trolley wires and the track, and the locomotives are furnished with two trolleys; the ascent being, of course, at a perfectly constant and uniform speed.

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**Electricity in Agriculture.** — The (London) "Electrical Review" abstracts at some length an article on this subject, recently appearing in "Electrotechnische Zeitschrift," describing two successful installations of electric plowing. It is stated that, in Germany at least, the cost of electric plowing compares favorably with that of steam plowing. In the first case described a farm is supplied with its whole light and power from a central station of 60 h.p. Alternating current at 1000 volts is generated and used principally for lighting. For driving the pumps, threshing-machines, plows and other machinery, a direct current at 500 volts is used. The director of the farm estimates the total consumption of energy at about 110,300 h.p. hours per year, about half of which is used for working the plow. Two hundred and fifty acres are plowed annually, and the estimated cost is $7.81 per acre.

On the royal farms in Prussia similar experiments have led to similar results. A communication to the Minister of Agriculture in that State puts the cost of electric plowing in heavy soil with deep cultivation at from $11.25 to $14.25 per acre, as against steam-power plowing at $21.25 per acre.

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The mechanism used at Dahlwitz, the farm mentioned above, is extremely simple. The motor wagon contains a motor driving the winding drums, and the motor may also be coupled to the driving wheels of the wagon to give it the proper advance at the end of each traverse of the plow. Three men are required to tend the apparatus. The depth of the furrow is 8 ins. to 10 ins., and the speed of plowing about 3 ft. per second. At this rate of working, the consumption of current varied from 30 amps. to 50 amps. at 500 volts.

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**Electrical Machinery in Australia.**—An article in a recent number of "L'Eclairage Electrique" gives the views of the French Consul-General in Australia as to the market for electrical machinery, and especially telegraph and telephone apparatus in that country. It is interesting to note that the imports of these articles for the year ending July, 1898, showed an increase of value of over $400,000 over those imported the year before, and the French official bewails the fact that none of these goods were French. He says that the imports came principally from England, the United States, Germany and Belgium. He reaches the conclusion that the only way in which the French manufacturer can successfully enter this market is by thorough study of the electrical conditions, so that he can exactly meet the demand to which these give rise.

This is an eminently sensible idea. The fact that such studies have not been made has led to the loss of much trade by English firms doing business in the Colonies. The expansion of German commerce into the remote parts of the earth has been very largely due to the intelligent study by German manufacturers of the conditions of the markets, including the desires of the purchasers. A striking instance of this was noticed recently in the Continental papers. A large German electrical manufacturing establishment sent two young men to China, where both were to study the language and become familiar with the conditions. At the end of a certain time one is to return to the office in Germany, while the other remains in China, and in this way a perfect understanding will be established between headquarters and the outpost of trade which they proposed to establish in the East. The idea is so good that it is certainly worth while for American manufacturers desiring foreign trade to give it careful attention.

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**Telephone Line Protection in Switzerland.**—The Swiss Governmental Bureau of Telephones has issued a circular describing at great length and with much care the precise methods that shall be adopted by all users of telephones and telegraph apparatus in that country for the protection of their lines and instruments against heavy currents and lightning. The circular is described at some length by "L'Eclairage Electrique," from which the accompanying illustration is taken. The most interesting details are those connected with telephone protection, and the method recommended is shown in the diagram. At a point upon each side of the circuit, immediately upon its entrance into the building, is placed a tube containing the usual fusible wire cut-out, the length of the tube depending upon the voltage of power currents in the neighborhood. Between these fuses and the apparatus to be protected are heating-coils, which open the circuit for a steady current of 0.2 amp. flowing for a few minutes. The fuses blow at a current of 2 amps. The telephones are required to be mounted upon marble or slate boards, as are the various parts of the protective system. Between the connections of the fusible wire and the heating coil is attached an ordinary carbon lightning arrester, as clearly shown by the figure. In addition to these precautions to be taken by the operator of the telephone line, the owners of high-current lines of whatever sort are required to protect their

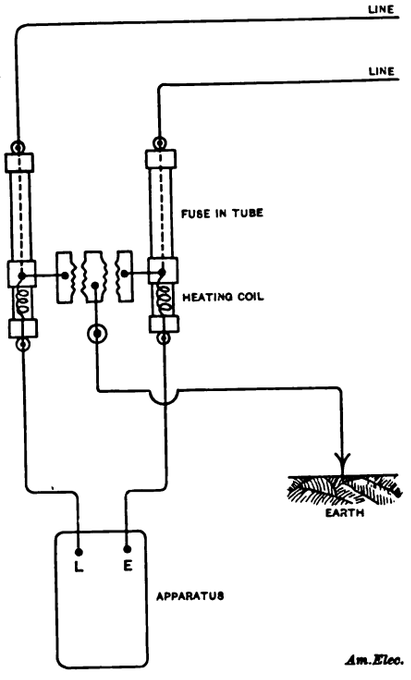



DIAGRAM OF TELEPHONE PROTECTIVE APPARATUS.

wires, at points where they cross telephone and telegraph lines, with a network of wires bound together to form a structure sufficiently strong to resist snow, high winds and the usual strains, and to sustain the weight of any number of telegraph or telephone wires or cables that may possibly fall upon it. The Swiss seem reasonably certain, if these rules are carried into universal effect, to be safe from any accidents due to the causes against which they guard in this manner.

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**Electrical Waves and Selenium.**—"L'Elettricitá" abstracts from an article by Sig. B. Agostino, appearing in "Nuovo Cimento," upon researches as to the susceptibility of selenium to electric waves. The analogy existing between electro magnetic and luminous phenomena led the author to suppose that electric waves would perturb the conducting qualities of this material in a way analogous to the effect of visible light. The selenium was crystallized in small glass tubes having electrodes at their extremities and connected in one of the branches of a Wheatstone bridge. The tubes were placed in the focal line of a cylindrical reflector, which received the radiation from a Righi oscillator. Heavy metallic screens were interposed between the spark-gap and the Thomson galvanometer and electrometer used in the measurements. The result of the experiment made with the selenium tube in darkness, or exposed only to the action of the electric waves, showed a very small change in its resistance (not more than 1.5 per cent at most), and in some cases showed a diminution and in others an augmentation of the resistance. On account of these variations being of about the same magnitude as the limits of error of the experiments, the author concludes no variations can be attributed to the direct action of electro-magnetic waves.

This singular fact seems to indicate that the peculiar effect exercised by radiation upon selenium is confined to definite wave lengths. So far as the writer knows there have been no experiments made, until these described above, upon the action of radiation of wave lengths, other than those of ordinary visible light, upon this interesting material. As it seems unquestionably certain that the first definite steps in the direction of seeing by electricity, or transmitting light as we now transmit sound, will be in some way through the agency of selenium, it would unquestionably repay any experimenter having the necessary apparatus at his disposal to study this whole question at length.

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**An Electrical Barber Shop.**—"L'Electricien" gives a very animated description of a barber shop in which most of the familiar operations are conducted by electricity. For example, hot water is obtained by passing the stream of a hydrant through a German silver tube in a soapstone case, the tube being electrically heated, so that the water is nearly boiling when it passes out at the spigot. "For the crimping of the frizzes of our young ladies there is no longer necessity for recourse to the hot iron. For a long time the defects of this method of heating have been noticed, for the capillary artist sometimes forgets and leaves the iron in the heating apparatus too long, so that when it is used with blonde or brown hair, if it does not make a burn, it makes the hair red, which is even more disastrous." The new curling irons heat themselves. In the interior of the rods is a ferro-nickel wire, which can be brought up to the proper temperature and will then remain at this same temperature indefinitely.

But it is in the cutting of the hair that electricity has produced the most complete revolution. The scissors have slowly given way to clipping machines, and these, in their turn, must disappear before an electrically heated platinum wire, with which the hair may be burned off. The apparatus as described, consists of a metallic comb, along one side of which is stretched the hot wire, and as this is passed through the hair, the red hot wire burns it off neatly and smoothly, and at the same time seals up

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the ends of the hair; it being supposed in this way to produce a very desirable effect. The method is, of course, entirely antiseptic, but it hardly seems likely that the air of a barber shop will be very pleasant when these new methods obtain a wide popularity.

**Electric Metal Working.**—M. H. Brillié publishes, in the "Revue Générale des Sciences," a very important article upon the various methods of electric smelting, forging, soldering, etc. His paper is one of great thoroughness and value, and deals largely with the developments of these subjects in the United States. Among the numerous processes mentioned, however, are some that are worthy of particular note,

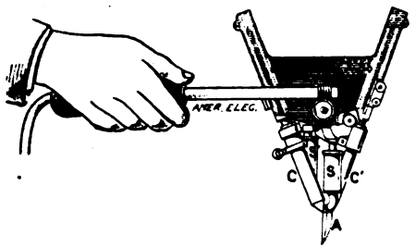



FIG. 1.—ZERNER'S ELECTRIC BLOW-PIPE.

and of these a few are described in detail below.

The electric blow-pipe of Dr. H. Zerner is illustrated in Fig. 1. The principle of this invention is extremely simple. An arc at a potential difference of about 85 volts and with a current of 20 amps. is established between the carbons C and C'. The two coils, S, are solenoids producing a magnetic field in a direction at right angles to that of the arc, causing the latter to be projected to one side, as shown at A. The regulation of the carbons is effected by the screw V, as clearly shown in the figure.

This simple apparatus is used a great deal in England, especially in the manufacture of bicycles for brazing the tubes of the frame, and in work on thick plates of steel, as, for example, boiler iron. The great advantages possessed by this form of instrument are at once evident, as it is easily handled, light, and gives an exceedingly high temperature and at a very definite point. The author suggests that it could be usefully employed in nearly every situa-

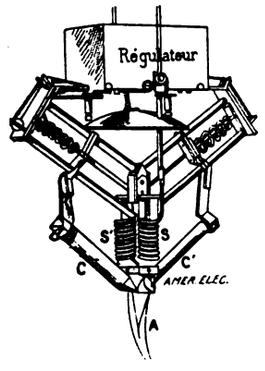



FIG. 2.—ZERNER'S ELECTRIC BLOW-PIPE.

tion where the oxy-hydrogen blow-pipe is now in use. It may be useful in the operation of lead burning in the manufacture of accumulators. Fig. 2 shows a similar apparatus, which is self-regulating and used for larger and heavier work than that described.

The Bernardos system was described at some length in these columns in the November issue. Fig. 3 shows an application of this method to the welding of a flange on a pipe. It will be noticed that the material upon which the work is being done is connected to the positive terminal of the circuit, while the carbon points, which are held in the workman's hands, are connected through the resistances, rr', to the negative side of the circuit. This operation is said to work with great rapidity and satisfaction, but a practical point of much importance in connection with it is to heat the metal to be operated upon to a dull red heat in an ordinary fire before exposing it to the arc temperature. The process is used considerably on the Continent for the repairing of boilers, cracks and fissures in steel plates being easily mended in this manner and filled up with melted metal.

The author mentions an exceedingly simple method of welding together end-wise two copper wires, or even wires of dissimilar metals, such as copper and platinum. They are connected, one to each side of a circuit of about 50 volts, and separated so that an arc plays between them. When the

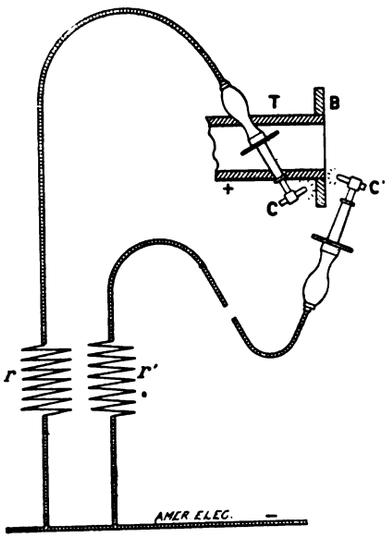



FIG. 3.—WELDING ON A FLANGE.

ends are white hot and melted they are thrust together and the current instantly turned off. The welding is said to be very perfect, and metals as dissimilar as copper and platinum may be readily welded together in this manner.

A very interesting application indeed is illustrated in Fig. 4. This is electrical heating by radiation. The figure shows the process applied to the soldering of metallic ornaments upon watch cases; *ss* are small spirals of platinum wire wound on the face of a slate block, upon which are laid the watch cases and, in position upon them, the metallic ornaments to be attached. Each case is covered by a metallic cover, C, which excludes the air and localizes the heat. Either continuous or alternating currents may be employed with perfect success, and the operation described above carried on with great celerity and cheapness.

M. Brillié's article goes into an extended

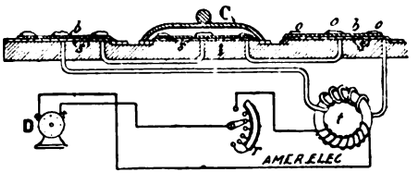



FIG. 4.—WELDING BY HEAT RADIATION.

description of many other processes to such a length that space does not permit its further abstraction here.

**Electro-Magnets on Cranes.**—Considering the enormous lifting power of electro-magnets, says "Le Génie Civil," it is astonishing that they are so rarely applied to hoisting and carrying apparatus. In all England there are only four or five. A description of these, abstracted by that journal, from "Glasers Annalen für Gewerbe und Bauwesen" may be of interest: At the Sandycroft Iron Works, in England, the hooks of all the cranes have been replaced by electro-magnets. One of them, which can sustain a load of two tons, consumes 5.5 amps. at 110 volts, or something less than a horse-power. It appears that on account of the saving of the time formerly required to attach the load to the hook, the same work can be done in an average of one-eighth of the former time required, and with three men instead of six. For loading cars with rolled iron and other metallic pieces the same economy has been noticed. At the Woolwich arsenal electro-magnets are used for the handling of projectiles weighing 790 pounds, intended for use in the 110-ton cannon of the English Navy. Formerly the handling of these monstrous projectiles was very troublesome, on account of the difficulty of properly slinging them in chains or ropes for attachment to the hook of the crane. The loss of energy occasioned by the use of these lifting magnets is absolutely negligible in comparison with the gain in convenience and saving of power occasioned by its use.

It will be remembered that the Illinois Steel Company, in this country, also uses magnets, of larger power than those described above, for handling steel bars and plates. The table above gives a comparison of the lifting power, current consumed, and weight of these magnets.

DATA OF LIFTING ELECTROMAGNETS.

| Lifting Power. | Power Absorbed. | Weight. |
|---|---|---|
| Sandycroft { 2,420 lbs.. | 606 watts, 0.8 h. p. | 297 lbs. |
| Sandycroft { 2,420 lbs.. | 220 watts, 0.29 h. p. | 253 lbs. |
| Woolwich 3,586 lbs.. | 120 watts, 0.16 h. p. | 44 lbs. |
| Illinois 12,880 lbs.. | 960 watts, 1.29 h. p. | ------ |

**Gas Driving for Small Electric Plants.**—An extremely interesting article in "L'Industrie Electrique" describes an installation for the production of wood gas, by the Riché process, for use in a dynamo-driving gas engine. Instead of burning the wood under a boiler in the usual way, if it can be converted easily and cheaply into gas and the greatly superior efficiency of

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the gas engine is utilized, there will be an evident saving in cost for fuel consumed. The Riché gas is intermediate in heating power between ordinary illuminating gas and Dawson producer gas and Siemens' gas, having a heating power of about 110 metric calories per cubic foot.

Wood gas has been known since 1798 and many varieties of apparatus have been invented for its production. The peculiarity of the Riché process is that the gas made by direct distillation of wood is passed through a red-hot column of the charcoal resulting from a former operation, and, by judicious admixture of air, practically the whole of the wood, with the exception of the mineral ash, is converted into gas. Its relative composition is well shown in the subjoined table:

COMPOSITION AND THERMAL POWER OF GAS ENGINE FUELS.

| Kind of Gas. | Percentage Composition. | | | | | Heating Power B. T. U. per cubic foot. |
|---|---|---|---|---|---|---|
| | H | CO | $CO_2$ | N | Hydro-carbons | |
| Illuminating Gas..... | 49.6 | 9.6 | 1.6 | 3.8 | 35.4 | 588 |
| Siemens' " ..... | 25 7 | 4.5 | 69.8 | ... | ... | 87 |
| Water " ..... | 49.2 | 43.8 | 2.7 | 4.0 | 0 3 | 324 |
| Dawson (coke) " ..... | 18.4 | 26.8 | 7.2 | 47.0 | 0.6 | 151 |
| Riché " ..... | 44.2 | 22.0 | 21.3 | ... | 12.7 | 340 |

Space does not permit a description of the details of the process, but a considerable series of experiments have proven that one brake horse-power may be had for about 35 cubic ft. of the gas, the engine working at full load. In France, where wood is considerably more expensive than it is in the United States, the cost of manufacturing the gas is in the neighborhood of 15 cents per 1000 cubic ft., and motive power produced through its agency costs, therefore, for combustible ,0.6 cent per horse-power hour.

For small installations in out-of-the-way places, where coal is expensive, it seems that this process has many points of great value, and that it is well worth the attention of engineers who are exploiting electrical installations in our new dependencies. For example, in Porto Rico inferior coal costs about $5 a ton, at the coast; it cannot be had for any price in the interior. Wood, however, can be had for the cutting anywhere.

**An Electrical Expedient.**—Our somewhat spirited contemporary, "l'Industrie Electrique," gives a short account of an expedient adopted at the village of Spoletá, in Umbria, to avoid the disappointment of the public, who were expecting the opening of a new transmission line intended to supply the place with light and power.

"All the preparations had been made to worthily receive the current, which was to come from 15 miles away. The walls of the houses had been newly white-washed, the window shutters given a fresh coat of green, and the local policemen rigged out in new uniforms. More than this; at great expense an excellent theatrical troupe had been secured to give a free show in the village theater. All was ready; the installation in the town, the transformers, the line from Spoletá to Marmora, and all that was lacking was the dynamos. Five days before the inauguration the manager of the affair learned, to his horror, that the dynamos were still at Buda-Pesth. Not to light the town, and, above all, not to light the theater, at the advertised time, would be an humiliation to be avoided at any cost. To put in a temporary steam plant and make a provisional installation could not be thought of, because the many-colored posters which had been distributed over a considerable part of Italy announced that the current was coming from fifteen miles away." The only solution was the one adopted.

A few miles away from the generating station was another, supplying the village of Rieti, also fifteen miles away, but in precisely the opposite direction. A temporary line was run and both circuits put together to work in series, the existing supply being of the constant-direct-current variety. At Spoletá a motor was put in this circuit, and drove a dynamo, which accomplished the lighting. The total length of the transmission was 68.2 miles, the constant current being of 30 amps., and about 200 h.p. in motors being included in the circuit.

It is believed that this is one of the longest commercial transmissions that has yet been made.

## NOTES.

**Electrical Exhibition.**—The stockholders of the Electrical Exhibition Company, which so successfully carried out the electrical shows held in New York in 1896 and last year, decided unanimously at a recent meeting to hold another electrical exhibition in New York in 1899. The following officers and directors were elected: C. O. Baker, Jr., president; H. L. Shippey, vice-president; Geo. F. Porter, secretary and treasurer; H. H. Harrison, L. F. Requa, J. W. Godfrey, C. A. Lieb, directors; Marcus Nathan, general manager. As these gentlemen were connected with two previous exhibitions, their experience gives assurance that the electrical show of 1899 will be a success flattering to the industry which it is to represent.

**Thickness of Transformer Plates.**—In an article in the November number of the "Physical Review," Prof. F. Bedell and Messrs. R. M. Klein and T. P. Thompson publish a mathematical investigation as to the best thickness of transformer plates. While eddy currents decrease as the plates are made thinner, the hystereses loss increases with such decrease, since the magnetic density increases, owing to the greater percentage of space between plates. The conclusion from the investigation is that there is a wide working range for the best thickness of plate, say, from 10 to 15 mils for practical purposes.

**Cost of Generating Machinery.**—In a paper read before the recent annual meeting of the American Society of Mechanical Enginers, Mr. Wm. H. Bryan gives some interesting figures as to the cost of boilers, engines, dynamos, etc., for a modern commercial building, consisting of three 125-h.p. engines and three 75-kw. dynamos. The cost of the water-tube boiler plant was $13.97 per rated horse-power; ordinary boilers would have cost $11.44 per horse-power. Compound engines, with foundations, cost $11.38 per rated horse-power; dynamos and switchboard, $22.80 per rated kilowatt capacity; wiring, lamps, fans and motors, per kilowatt of dynamo capacity, $42.10, or $83.90, including lighting dynamo and engines.

**Chicago Electrical Association.**—At the regular meeting of the Chicago Electrical Association, on Dec. 16, Mr. Arthur Vaughan Abbott, chief engineer of the Chicago Telephone Company, delivered a lecture on "Wireless Telegraphy," illustrated by practical demonstrations with working apparatus. Mr. Abbott has been experimenting and developing his apparatus during the past year, and has established communication between his office and residence, two miles distant. After the lecture, the annual election of officers was held, with the following result: President, Thomas G. Grier; vice-president, J. M. Hollister; treasurer, Harold Almert; secretary, Cloyd Marshall; directors, F. S. Hickok, E. W. Jewell and Hayward Cochrane.

**Wire Insulation.**—The Electrical Bureau of the National Board of Fire Underwriters, in proposing specifications for rubber covered wire and cables, gives the rule that the rubber diameter in inch measurement shall be 3/2 × copper diameter +.062. This insulation must also be protected by a substantial braided outer covering sufficiently strong to withstand abrasion, and sufficiently elastic on all wires smaller than No. 5 to admit of the conductor being wound back over itself without injury to the braid. The complete covering must show an insulation resistance of at least 100 megohms per mile throughout eight weeks' immersion in hydrant water at ordinary temperatures. Each foot of the complete covering must show a dielectric strength sufficient to resist throughout five minutes the application of an alternating e.m.f. of 16,000 volts under specified conditions.

**Steam Turbines and Unipolar Dynamos.**—In a letter to the London "Electrical Review" the manufacturers of the Parson's steam turbine, refer as follows to an editorial reprinted in that journal from our columns, on "Steam Turbines and Unipolar Dynamos." "The first and principal worker to develop this class of dynamo has been Prof. Forbes, and he has, from time to time, taken out several patents on the sub-

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ject. In 1886, not being aware of Prof. Forbes' works, we constructed a unipolar dynamo driven from a steam turbine, which, at 24,000 r.p.m., gave 1000 amps. at three volts, and we then patented the arrangement. In 1892 we supplied a unipolar dynamo constructed on Prof. Forbes' lines, but with considerable modifications, for the Elmore Company, which has worked successfully, and which, we believe, was the first unipolar dynamo put into commercial use. Its output is 6000 amps. at 1¼ volt, at 1000 r.p.m."

**Prof. Crocker in Japan.**—A Japanese correspondent sends us the following note concerning the recent visits of several distinguished Americans to Japan: "Japan has seen two great men in the electrical field during the latter half of this year. One is Mr. Alexander Graham Bell, so well known in connection with the invention of the telephone; and the other is Prof. Francis B. Crocker, the president of the American Institute of Electrical Engineers during the 1897-1898 term. The Japanese Institute of Electrical Engineers celebrated the occasion by entertaining these gentlemen at dinner in the famous Maple Club, in Tokio. Still another gentleman, now in Japan, connected with a very important matter of electric business, is Mr. James A. Scrymser, an American millionaire. He came to Japan with a view to securing a guarantee from the Japanese government for a subsidy on his project—a project for which we have waited so long, and the importance of which is so keenly felt, both in commercial and political circles—the laying of a sub-marine cable across the Pacific."

**Northwestern Electrical Association.**—The seventh annual convention of the Northwestern Electrical Association will be held at Hotel Pfister, Milwaukee, Wis., commencing on Wednesday morning, Jan. 18, next. The following papers will be read and discussed: "Trend of Central Station Design," by B. J. Arnold, Chicago; "Meter-Rate Systems," by E. L. Debell, Sheboygan, Wis.; "Design of Secondary Circuits in Alternating Plants," by George L. Thayer, Belle Plaine, Iowa; "Electricity Direct from Coal," by Prof. A. J. Rogers, Milwaukee; "Inductive Loads on Alternating Current Transformers," by Prof. D. C. Jackson, Wisconsin University; "Electric Vehicles and Their Relation to Central Stations," by H. M. Maxim, Hartford, Conn.; "Association Management," by H. L. Doherty, Madison, Wis. The association will, at this meeting, inaugurate the "Question Box" on a new plan designed to remedy the defects of that institution as usually conducted. Members are invited to mail to the secretary prior to Jan. 10, questions on any matter connected with their business upon which information is desired. All questions received will be printed and distributed with a request for prepared answers to be ready at the convention when called for. A banquet, theater parties, sleigh rides, etc., are being arranged for, and enjoyable entertainment for all is assured.

**Motor Vehicles.** — In a paper read by Mr. C. E. Woods before the Chicago Electrical Association, Nov. 18, some interesting data are given concerning electrical automobiles. Experiments by Mr. Woods show that solid rubber tires are more efficient than the pneumatic tire for use in moto-vehicles, the latter absorbing about 20 per cent. more energy. The lightest vehicle made by Mr. Woods is equipped with one 2½ h.p. motor and 36 storage cells of 16 ampere-hour capacity for two hours, which run the vehicle at a speed of fourteen miles per hour, carrying two people. The battery weighs 440 lbs. and the motor and vehicle 360 lbs., thus making a total weight of 800 lbs. The average of miles run on one battery charge is twenty. Another equipment, designed for four passengers, is an open vehicle, such as a trap or brake, and weighs, complete, 1800 lbs. The average of miles run on one battery charge is thirty, with two motors of 5 h. p. each. The discharge rate of the battery is 30 different storage batteries on the market which fill the requirements for a cab battery. Forty cells of one of the types weigh 1120 lbs. and give a 36-ampere discharge for three hours; the same number of cells of another type weigh 1500 lbs. for 37½-ampere discharge for three and a half hours; and 40 cells of the third type weigh 1000 lbs. for 36-ampere discharge for three hours.

**Electricity in Warfare.**— The December meeting of the New York Electrical Society was devoted to a consideration of the part played in the late war by electricity, and the further extensions in this field suggested by experience during the war. Addresses were delivered by Col. Eugene Griffin, who organized and commanded the First Regiment of Volunteer Engineers; Mr. F. W. Roller, late chief engineer of the U. S. S. "Nashville;" Mr. W. D. Weaver, late chief engineer of the U. S. S. "Glacier," and Captain Zalinski, inventor of the dynamite gun.

Col. Griffin gave an account of the organization and service of his regiment, which performed work of immense value during its short service in Porto Rico. He strongly urged the formation of a torpedo militia somewhat in line with a body of corresponding functions successfully established in England, and suggested the appointment by the Secretary of War of a commission of army officers to make a report of the subject. During the late war volunteer electricians performed most excellent service, particularly in the defense of Boston harbor, and if such an organization as was proposed were authorized, the professional electricians of which it would be composed would give, he believed, the first note of confidence to the nation on the outbreak of war, by promptly insuring adequate torpedo and mine protection to the navigable channels and harbors of every city on the coast.

Mr. Roller referred to the general failure of indicating apparatus aboard ship, and added that the unsatisfactory performance of the range finder could not be attributed entirely to electrical reasons, it being subject to a very considerable error on account of the shortness of the base-line. He spoke of the lack of electrical skill aboard ship, to which many failures were due. Electrical primers were not always satisfactory because of the low battery power employed, consisting of but several small dry cells. Electrical apparatus of a more robust nature gave very good satisfaction aboard ship, and he referred to the excellent service rendered by the Ardois signal system. The immense value in warfare of the search-light was dwelt upon; at Santiago it rendered impossible the escape of Cervera's fleet at night, not only illuminating the entrance of the harbor brilliantly, but, owing to the dazzling rays, rendering navigation of the tortuous channel exceedingly hazardous. The employment of electric power aboard ship, such as motors for ammunition hoists, turret training, ventilating fan driving, etc., gave eminently satisfactory results. The few failures that occurred were far less in number than those of the steam driving equivalents, and even then, in most cases, were traceable more to the lack of skill than to any inherent defects.

Mr. Weaver said that the lessons taught by the late war with respect to the employment of electricity aboard warships, though few in number, are important in their bearing. The most decisive results were the demonstration of the immense superiority of electricity over steam for the operation of turret-training apparatus, and the great success of electrical ammunition hoists. He referred to the failure of electrical range finders and of electrical indicating apparatus in general. He considered, however, that the Fiske range finder is inherently defective, and suggested the employment of an alternating current range-finding system similar to one proposed by Messrs. Crehore and Squier. The experience with electric power aboard ship proved to be very favorable, and its extension was urged. Among the cases mentioned distinctly calling for such application were in electric ventilation and in driving the work-shop machinery, ice machine, winches and ash-hoists. Mr. Weaver considers that the present steam pumps and some of the auxiliaries connected with the main engine should also be driven by electric power, as well as the anchor-hoists and steering-gear. In every case possible, however, new electrical applications, he said, should be thoroughly tried aboard merchantmen before endeavoring to place them aboard a warship, as the latter is no place for experimental work or the trial of new applications. The inefficiency that the war showed to exist in the electrical personnel aboard ship was referred to, and the present policy of the Navy Department and the present bureaucratic tendency to call a halt in the further use of electricity aboard ship were criticised. The suggestion was offered that the present unsatisfactory condition of the electrical engineering department aboard warships should be made the subject of a departmental, or even congressional inquiry.

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To the sixteen thousand patrons of the AMERICAN ELECTRICIAN, as well as to its other readers and all connected with the electrical industry, the AMERICAN ELECTRICIAN wishes a most happy and prosperous New Year. We are happy to state that all the indications point to a most successful year for the industry.

**The Central Station Load Curve.**

In another column we print an article descriptive of an extensive refrigerating plant very largely utilizing electric power, and which is particularly interesting from the number of special fittings used and as an illustration of the flexibility of electric power. One of the objects, however, in preparing the article was the lesson that would be contained in it for central station managers seeking a solution to the problem how to flatten the load curve. A refrigerating and ice-making plant furnishes an almost ideal solution, for one can conceive of an arrangement whereby practically a flat load curve may be maintained over the twenty-four hours, in this respect almost rivaling the case where surplus power is used to operate a pumping plant.

**Improvement of the Steam Engine.**

In this number is printed the first half of an article by Prof. Durand on the improvement in the economy of the steam engine, which will be found a concise and valuable résumé of the principles upon which further improvements in efficiency must be based. It is pointed out that the present efficiency may be increased by the use of higher pressures, and by increasing the working efficiency of the steam—that is, increasing the percentage utilized of the entire heat in steam which is available for producing mechanical work. Aside from the practical difficulties in the way of using steam of very high pressures, the second method applies at all pressures, and if utilized at present pressures, the economy at higher pressures will probably be correspondingly enhanced. The concluding section of the article will discuss the several practicable methods of increasing the working efficiency of steam, such as in the use of superheaters and receiver reheaters.

**Alternating Current Motors.**

Owing to the mystery with which alternating currents have been surrounded in the minds of so many—possibly partly owing to the distinctive nomenclature and partly to the former method of treating the branch mathematically in a manner giving the impression that one not versed in higher mathematics could not pursue its study—the applications have not become so clearly understood as they should. In this number appears the first portion of an article from the pen of Mr. Ernst T. Berg which gives a complete résumé of the practical principles of alternating current motors. This article will be found of much interest, giving as it does the peculiarities of the various types of machines now in use and pointing out the applications to which each is best suited. In addition, the subjects of torque, idle current, frequency and speed regulation are treated in their practical aspects.

**Polyphased Electric Railways.**

An article in another column describes a Swiss mountain polyphased electric railway which, though of a very special kind, nevertheless brings out the flexibility in distribution peculiar to the employment of alternating currents. While the system described would be directly applicable to suburban and interurban town traffic, it lacks the quality of speed regulation so necessary in all other cases. It is true, almost perfect speed regulation without loss of torque may be secured with the induction motor, but as in the case of the direct-current series motor under rheostatic control, the efficiency decreases rapidly with the speed, practically the same power being taken at low speeds as at one approaching synchronism.

Where the stops are infrequent, this would not be a matter of moment, so that for such cases the application of the induction railway motor in itself presents no difficulties, and in operation and flexibility of power distribution is vastly superior to the direct current motor. But two other factors intervene—the double trolley and the line inductance. It is quite probable that the evils of the former have been exaggerated, and where a considerable number of cars are run, thus producing an approximately constant inductance effect, this can be neutralized where the employment of synchronized motors in circuit is practicable.

**An Electrical Militia.**

The suggestion of Col. Eugene Griffin that a national militia organization composed of electricians be formed and trained in time of peace to assist in harbor defense and coast communication during war, is one that should meet with the hearty support of our readers. One of the recommendations of the plan proposed is that the organization of such a corps would not be in the nature of an experiment. Great Britain has its corps of Volunteer Electrical Engineers, now under the command of the well-known electrical engineer, Mr. R. E. B. Crompton, and in whose formation the late Dr. John Hop-

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kinson was a leader. So satisfactory has this corps proved that it is about to be greatly enlarged.

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But we need not look abroad for arguments in favor of the measure. At the beginning of the late war a volunteer electrical corps was formed in Boston, and under Mr. Caryl D. Haskins and Dr. Louis Bell did most excellent work in the service which it is now proposed to organize on a national basis. The case with which Col. Griffin recruited the electrical contingent of his command, the First Regiment of Engineer Volunteers, for foreign service, and the excellent work it performed in Puerto Rico, are evidence of the spirit in which electricians generally would welcome the proposed organization, and of the earnestness in which they would assist in furthering its aims, either in person or by extending a moral support.

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Those who fear that it would introduce another parade element in the militia system may disabuse their minds on that score, for, composed as the organization would be of men of technical skill engaged in a service involving technical work, it would be characterized by a spirit having little in common with that of a holiday marching militia. Nor would the body conflict with the present naval militia, for the natural occupation of the latter is in duty afloat, and patrol and auxiliary service in time of war will fully supply this. It is earnestly hoped that Col. Griffin's suggestion of the appointment of a board of army officers to report on the proposed plan will meet with favor in Washington.

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**The Power and Pull of Electromagnets.**

A problem which frequently confronts the electrical designer is the following: Given a magnet of known shape, size, excitation and magnetic material, what is the pull upon an armature of known materials and dimensions at a specified distance? There is absolutely no reliable data on this subject. The matter of leakage enters into this problem so intricately that it is impossible to apply any mathematical formula, either rational or empirical. It is frequently the case that data of the most approximate character in this direction would be very welcome, and this it should not be impossible to experimentally obtain.

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In connection with this subject it seems wise to suggest a series of experiments with a number of magnets with known dimensions, beginning with those of very minute size and proceeding upward to the largest size that would ever be used in electro magnetic mechanism where the function is to exert a tractive force. The experiment would not be particularly expensive. It would be somewhat tedious, but the results would be of incalculable value. With a single set of magnets the attraction of armatures of various shapes and sizes could be measured, and also the attraction of these magnets under the influence of alternating currents. The tabulated results giving magnetizing force, saturation of the cores, the dimensions of the magnets, and the pull at various distances, would constitute a valuable contribution to engineering data and place the profession under a very great debt of gratitude to the author.

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Mr. Charles P. Steinmetz gave to the public the results of his invaluable researches on hysteresis, which at once made his name a familiar one the world over. It is to be earnestly hoped that the same spirit which animated him to make his admirable investigation and his no less admirable classification and discussion of the results, may influence some competent engineer who has opportunity at his disposal to follow in Mr. Steinmetz's footsteps, and make a similar research on the power and pull of electromagnets, which, even should it result in nothing more than a collection of experimental data, would be most widely appreciated.

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**Electrical Engineering in the Navy.**

The record of the navy during the late war has been such a glorious one that any criticism which seems called for can be freely offered, with the knowledge that it will not affect injuriously the prestige of this great arm of national defense. It was not to be presumed, in view of the great changes of recent years in material —amounting, in fact, to a revolution—that the test of war should not bring to light some weaknesses. While as a whole the American warship has withstood this crucial test in a magnificent manner, it appears that one of the departments aboard ship—that having cognizance of electricity—has showed signs of most alarming weakness.

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To merely quote an official utterance in support of this opinion, the following extracts from the report of the Chief of the Bureau of Equipment, which has charge of naval electrical engineering, show a state of affairs both unexpected and disquieting: "The bureau regards with much concern the constantly increasing demands for repairs and renewals to the electrical outfits and supplies of ships. While there are some notable exceptions, such as ships on the Asiatic station and the 'Oregon,' the experience of ships on the home station would seem to indicate that they cannot long be self-sustaining without dockyard electrical work." "The number of officers who are familiar with electrical engineering seems to be decreasing rather than increasing."

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The relative smallness of the electrical plant aboard ship, and the superior reliability of electrical machinery which a long-extended experience in its operation has thoroughly demonstrated, are facts which both point as a cause of the failure implied, not to deficiencies in the plant itself, but to defects in the organization of the electrical engineering department of the navy. This latter, in fact, is tacitly acknowledged in the report quoted, for the recommendation is made that a specially trained corps of officers and men be organized for naval electrical engineering service. This recommendation does not necessarily reflect upon the zeal of the officers now having charge of the plants of warships, for their service in this connection is incidental to their navigating duties, and, in any case, a line officer cannot afford to neglect his distinctive military profession to the extent that would be necessary to thoroughtly qualify him as a professional electrical engineer.

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The unsatisfactory condition of the naval electrical engineering department doubtless led to the recent action of the Navy Board of Construction in refusing, by a vote of four to one, to further extend the application of electric power aboard warships. It was proposed to operate electrically most of the auxiliary machinery aboard the new battleships, and the action referred to, since there is nothing experimental in electric fans, blowers, pumps, etc., can only be considered the result of a lack of confidence in the present naval electrical engineering system—a lack of confidence, moreover, on the part of officers thoroughly acquainted with the system. Whether or not the remedy suggested by the Chief of Bureau is the proper one to apply should be a matter for inquiry. The sooner this inquiry is made by the Navy Department or by Congress the better it will be for the navy, for the present condition is little creditable to this otherwise splendidly competent service.

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## DESIGNS FOR SMALL MOTORS.

### ONE HORSE-POWER BI-POLAR MOTOR, WITH DRUM ARMATURE.

BY CECIL P. POOLE.

The armature core and field magnet frames, described in the preceding issue, may be wound for any voltage desired, but the most efficient windings, as the cores now stand, will be those specified below.

#### ARMATURE WINDING.

The armature core, after being finally assembled, is to be made ready for windings by applying the insulation. Cut out four discs of heavy canvas, 3 ins. in diameter, with a ¾-in. hole in the center; varnish two of them on one side with shellac varnish, and apply them to the end plates of the armature core, varnished sides in. The edges will turn over to cover the outer edges of the plates, and will have to be slitted at intervals of ⅛ in. all around to prevent bunching up. After putting on these varnish their outer faces, and one face of each of the remaining canvas discs; when the varnish begins to thicken put on the two other discs, one at each end, and apply considerable pressure to them until they dry. This is best accomplished by boring a hole in a piece of plank, large enough to pass the shaft, and setting the core on the plank, on end, next putting a short piece of board (6 or 8 ins. square) with a hole in its center on the upper end of the armature, and piling any convenient pieces of heavy scrap on the top board.

Next insulate the slots with troughs of oil paper, 1/64 in. thick, such as is used with the ordinary office outfit for copying letters; each trough should consist of two thicknesses of the oil paper, and the floor of the trough should be 4¼ ins. long, so as to project a little beyond the iron of the core and rest upon the edges of the canvas discs, which were previously turned over to cover the edges of the end plates.

The coils may then be wound directly in the slots, each coil consisting of twenty turns of No. 18 wire, four wide and five deep. Each slot will contain, when the windings are complete, half of each of two separate coils. It will facilitate the winding and insure electrical balance (as nearly as a core wound armature can be balanced) if the builder will make a diagram of his armature disc, numbering the slots from 1 to 24 successively around the circumference, as shown by Fig. 1. Then the winding will proceed as follows:

| | | | | | No. | | | | No. |
|---|---|---|---|---|---|---|---|---|---|
| First | coil | starts | in | slot | 1 | ends | in | slot | 12 |
| 2d | " | " | " | " | 13 | " | " | " | 24 |
| 3d | " | " | " | " | 17 | " | " | " | 4 |
| 4th | " | " | " | " | 5 | " | " | " | 16 |
| 5th | " | " | " | " | 9 | " | " | " | 20 |
| 6th | " | " | " | " | 21 | " | " | " | 8 |
| 7th | " | " | " | " | 3 | " | " | " | 14 |
| 8th | " | " | " | " | 15 | " | " | " | 2 |
| 9th | " | " | " | " | 19 | " | " | " | 6 |
| 10th | " | " | " | " | 7 | " | " | " | 18 |
| 11th | " | " | " | " | 11 | " | " | " | 22 |
| 12th | " | " | " | " | 23 | " | " | " | 10 |
| 13th | " | " | " | " | 22 | " | " | " | 11 |
| 14th | " | " | " | " | 10 | " | " | " | 23 |
| 15th | " | " | " | " | 18 | " | " | " | 7 |
| 16th | " | " | " | " | 6 | " | " | " | 19 |
| 17th | " | " | " | " | 14 | " | " | " | 3 |
| 18th | " | " | " | " | 2 | " | " | " | 15 |
| 19th | " | " | " | " | 20 | " | " | " | 9 |
| 20th | " | " | " | " | 8 | " | " | " | 21 |
| 21st | " | " | " | " | 16 | " | " | " | 5 |
| 22d | " | " | " | " | 4 | " | " | " | 17 |
| 23d | " | " | " | " | 24 | " | " | " | 13 |
| 24th | " | " | " | " | 12 | " | " | " | 1 |

After winding the first two coils, thin strips of varnished muslin should be laid over them, across each armature head from slot to slot, so that the next two coils will be insulated from the first pair; each successive pair of coils should receive this treatment, and after the slots are half filled (twelve coils being put on), a strip of oil paper 7/32 in. wide and 4¼ ins. long must be laid in each slot on top of the coil already in place before proceeding to put on the coil which next goes in that slot.

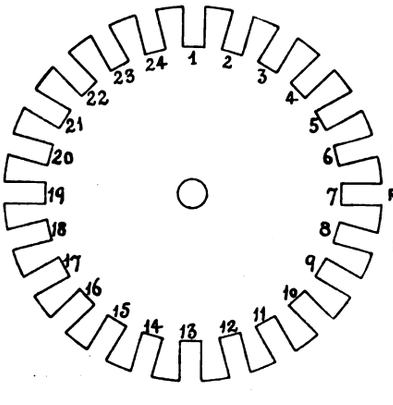



FIG. 1.—WINDING DIAGRAM.

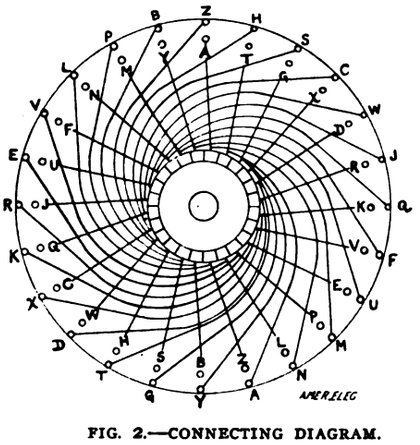


FIG. 2.—CONNECTING DIAGRAM.

The starting end of each coil should be kept leading out straight from its slot, and the finishing end should be brought across the head and secured to the starting end by a turn around it. When the winding is complete, untwist the finishing end of each coil from its starting end, and twist it and the starting end of the next coil to the right firmly together. This will leave twenty-four terminals to lead out to the commutator lugs.

Before connecting the ends to the commutator, the binding wires should be put on and the winding tested for grounds on the core. The binding wires are put on in two bands, and consist of small tinned iron wire; they should be put on beginning 1 in. from each end of the core, and making each band ½ in. wide. The binding wire should be wound on strips of thin varnished muslin laid around the core two layers deep, and the bands should be soldered at four equidistant points around the armature surface, not all the way around. The wire used should be not larger than No. 22 B. W. G. or No. 20 B. S. G.

Unless the machine is likely to be used in very dusty surroundings it is better not to put any covering over the ends of the armature after the winding is complete. If the instructions for insulating each pair of coils from the succeeding pair have been carefully followed out, any ordinary collection of dust will not be liable to cause a breakdown in the heads. The winding just described is intended for a 110-volt machine. If it is desirable to wind the armature for a 220-volt circuit, use No. 21 double cotton-covered wire, making each coil five turns wide and six layers deep.

The commutator had better be purchased from any well-known manufacturer of commutators, as its market price will be less than the cost of material and labor necessary to make one properly. It must have twenty-four segments and be not more than 2 ins. long along the shaft; the diameter does not matter particularly—take one of a stock size from the maker. In connecting up the coils to the commutator carry the ends previously twisted together straight out to the commutator segments. Fig. 2 shows the connections diagrammatically. The slots are omitted and each coil is represented as having only one turn for the sake of simplicity. The coils are lettered, to facilitate identification of opposite ends. The ends leading straight to the commutator are the starting ends; those leading around being the final ends. The diagram is not intended to show the relative radial positions of the coils, and care must be observed to avoid becoming confused. For example, coil A may or may not be under coil Z at its starting side; they are both in the same slot, but it does not matter which is on top. If coil A was the first one put on, it will, of course, be in the bottom of both of its slots, and coil Z will come on top of each side of it. The diagram only shows the relative angular positions of the coils and the manner of connecting their ends.

The brushes should be of carbon, ⅜ in. thick, and of a width ⅛ in. less than the length of the commutator face, which should be about 1½ ins. The brush holders may be copied from any standard type to which the builder of this motor has access, except those of the Baylis design, made by the C & C Electric Company, which are patented.

#### MAGNET WINDINGS.

The iron-clad magnet requires two magnet coils, one on each pole; for 110-volt circuits these coils consist of No. 22 wire wound in 61 layers, each layer being 50 turns long. If both the coils are wound in the same direction—in other words, if they are precisely alike as to the manner of winding, as they should be—the beginning end of one must be connected to the final end of the other, the two remaining ends being carried to the terminals of the machine. The best arrangement is to connect the two ends that are farthest apart, making this connection on the pulley side of the machine. For 220-volt circuits the wire must be No. 25 gage, wound to a depth of 75 layers, 65 turns to each layer. These

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coils should be wound on a block, the cross-section of which is of exactly the same shape as that of the magnet core at its largest part, but which measures ⅛ in. more in each direction. After winding each coil, tie it at each corner with coarse linen thread (cobbler's thread) and cover it with strips of muslin wound at right angles to the direction of the wires, and so put on as to have the edge of each convolution of muslin lay just alongside that of its neighbor—touching it but not lapping it. The muslin must be one-fourth the width of the inner edge of one side of the coil, so that four turns will cover one side evenly. Put the muslin on in two layers, the turns of the second layer covering the joint between the turns of the first layer. Then wind strips over the corners of the coils, two layers deep. After the coil is covered with one layer, varnish the muslin covering heavily with shellac; when this is nearly dry, put on the next layer and the corner strips, and after varnishing the whole, set the coil aside to dry. Do not put any varnish on the wire itself. Next cover the iron cores of the machine with a layer of muslin, this time lapping the edges of successive convolutions; varnish the muslin, and when it and the coils are thoroughly dry, put the latter on. Unless the pattern for the field magnet has been very exactly made, and the casting is an unusually perfect one, it may be necessary to file the corners of the pole pieces slightly to get the coil between them in putting it on the magnet core. In filing these corners, be careful to round them, leaving no sharp corners or edges whatever. It is advisable to do this, even if it is not mechanically necessary for the introduction of the coils.

The Jenny type of magnet has only one magnet coil, which consists of No. 25 wire, wound to a depth of 65 layers, with 148 turns to a layer, for 110-volt service. For 220 volts, use No. 28 wire, wound to a depth of 81 layers, 186 turns to each layer. All the wire specified herein for both armature and field windings should be double cotton covered. Circular magnet heads of vulcanized fibre should be used to protect the ends of the coil, as the full voltage of the machine exists between these ends; these heads should be ⅛-in. thick and 6⅜ ins. in diameter, with a hole to fit the magnet core snugly if the coil is wound directly on the core. If not, a bobbin should be made, the center consisting of a tube of 1/32 in. fibre, 4¼ ins. long, and of an internal diameter to go easily over the core; the heads of the bobbin to be of ⅛-in. fibre, as above. If the coil is wound on the core, the latter must be covered with three layers of muslin, each layer varnished with shellac. The whole must dry thoroughly before the wire is wound on.

The data of the machine are as follows:

IRON-CLAD TYPE.

| | 110 volts. | 220 volts. |
|---|---|---|
| Resistance of armature winding | 1 ohm. | 3.15 ohms. |
| Armature capacity, maximum. | 8.3 amp. | 4.7 amp. |
| Armature capacity, normal | 7 amp. | 3.8 amp. |
| Armature loss, $C^2R$, normal | 49 watts. | 45½ watts. |
| " hysteresis " | 11.7 " | 13 " |
| " eddy currents | 1.3 " | 1.5 " |
| Total internal armature losses. | 62 " | 60 " |
| Magnetic flux per sq. in. in armature core | 71,800 | 72,000 |
| Revolutions per min., loaded | 1,800 | 2,000 |
| Resistance of field winding | 220 ohms. | 682 ohms. |
| Current in " | ½ amp. | 0.322 amp. |
| Heat loss in " | 55 watts. | 70.85 watts. |
| Density per sq. in. in core | 38,000 | 38,160 |
| " " " gaps | 25,500 | 25,570 |
| Efficiency, approximately | 76% | 75% |

SINGLE COIL TYPE.

| | | |
|---|---|---|
| Armature data same as above. | | |
| Resistance of field coil | 443 ohms. | 1,400 ohms. |
| Current in " | ¼ amp. | 0.16 amp. |
| Heat loss in " | 27½ watts. | 35.2 watts. |
| Density per sq. in. in core | 89,750 | 90,000 |
| Efficiency, approximately | 78% | 79% |

An amateur motor builder will be wise not to attempt to make a starting box for this size of machine; one can be purchased for a moderate sum from any of half a dozen reputable manufacturers, and, as either of the motors here described is well worth the outlay necessary to insure its protection in this particular, the writer advises buying the starting rheostat.

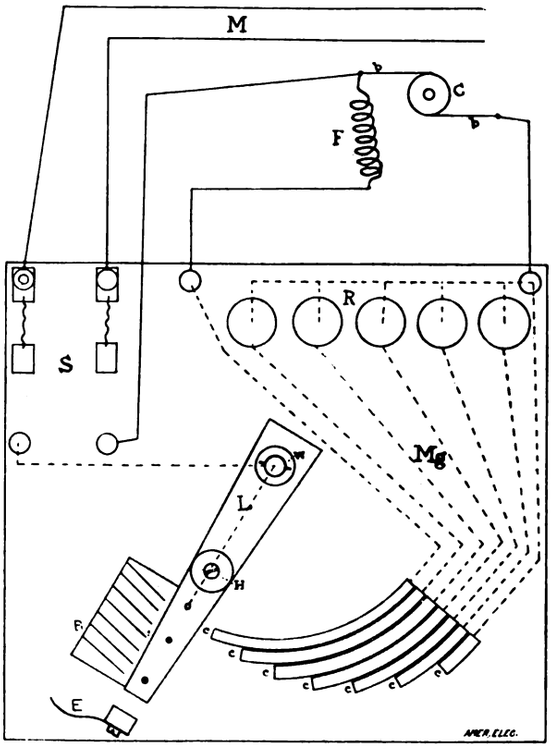



FIG. 3.—STARTING RHEOSTAT AND CONNECTIONS.

If, however, the reader particularly desires to make his own starting rheostat, the arrangement shown by Fig. 3 will be found easier to construct than anything in the shape of a wire rheostat. In the sketch, L is the lever, pivoted on a ½-in. metal post, and normally forced downwardly by a coil spring of three or four turns (not shown), which is located under the washer, W. A pin through the post secures the washer, spring and lever. H is the handle; a wooden handle, such as coffee grinders are given, or a large porcelain knob will answer. B is the contact brush of copper, slitted tangentially to the circles of the contact strips, c, c, c, c, c, c, c; these circles have their common center, of course, in the center of the post on which L is pivoted. An end view of the brush, B, is given by E, showing the convex shape given the under face of the brush to enable it to pass smoothly over the contact strips. The ends of these should be beveled to avoid digging into the brush.

The connections are shown diagrammatically. R is a bank of five 32-c.p. incandescent lamps, rated at 110 volts (100 will be better, and they can probably be readily obtained); C is the motor commutator; b, b, the brushes; F, the field winding; S, a double-pole combined switch and fuse block, and M, the service mains. A glance at the connections will show that the functions of the lever L are to first connect in the field, next the armature in series with one lamp; at each successive step a lamp is added in parallel with the first one until all are in, and the last position of the lever cuts out the lamps, leaving the armature in circuit direct.

The lamps should be mounted on the base with the lever and contacts, and it is preferable, though not particularly urgent, that the switch S be mounted on that base also. The sketch shows the lever in the "off" position; the switch, S, should never be closed, except when the lever L is in this position. If the reader desires to make the arrangement automatic he need only add a retractile spring to pull the lever L to the "off" position; a bar of iron ⅛ in. by ¼ in. by 2 ins. on the right hand edge of the lever, and a small magnet connected in series with the field, F, and located on the base about Mg, in such a position that it will hold the lever, by means of the bar of iron, when it is brought to the "on" position.

## CONDUCTORS FOR THE THREE-WIRE SYSTEM.

BY WM. HERBERT DONNER.

The advantages of the three-wire system of arranging a lighting circuit have been often pointed out and commented upon; nevertheless, it cannot be said that all engineers are able to explain correctly what the saving in copper really is, as compared with the ordinary two-wire method of running leads. The reason is that there are two ways of regarding the matter. We may require an equal drop of potential along the line in the two cases, or an equal *percentage* of drop, and the size of wire will be different according as we work by one or another of these formulæ.

It is frequently stated that the amount of copper used in the outer conductors of the three-wire system is one-fourth of that required in the ordinary two-wire system, the explanation being that the working e.m.f. is doubled, thus necessitating one-half the cross-sectional area of wire, and the current is halved, thereby cutting down the copper section by another equal amount. These two reductions then constitute a total reduction of area to one-fourth the original size.

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But the loss in the two systems will not be the same if this process is carried out. A very simple proof may be deduced from a consideration of Ohm's Law. Suppose we have a two-wire circuit supplying current for 100 lamps, each lamp taking one-half ampere at 100 volts, and that the drop from generator to lamps is 5 per cent. The e.m.f. at the generator will be $\frac{110}{95} = 115.8$ volts, and the drop of potential will be $115.8 - 110 = 5.8$ volts. Then the resistance of the leads will be $R = \frac{5.8}{50} = .116$ ohms.

Now, if we figure on the three-wire system and allow only one-fourth the weight of metal in the outer leads, the resistance of these leads will be quadrupled and we shall have $R = .116 \times 4 = .464$ ohm. Then, since two lamps are in series throughout, the current is halved, and the drop $E = CR = 25 \times .464 = 11.6$ volts. Obviously, if we desire the same drop from generator lamps, it will not do to calculate by means of the above rule. What we have obtained is, however, the same *percentage* drop of potential, for 11.6 bears the same ratio to 231.6 (which is the doubled potential of the generator) as 5.8 does to 115.8. In both cases the drop is 5 per cent.

It will now be evident that any rule for determining the size of wire for a given drop of potential (not percentage drop) which is based upon a reference to previous calculation for the two-wire system should specify a size which is one-half the cross-sectional area of that necessary for the latter system. An excellent, and well-known, rule for calculating a two-wire system is that the required resistance per foot of the conductor should be equal to the drop in the circuit, exclusive of the lamps, divided by the product of the number of lamps and the single distance.

This simple rule is true only in the case of 110-volt circuits and 16 c.p. lamps, but may of course be modified to suit any current or e.m.f by inserting a suitable coefficient. The derivation of the rule mentioned is that the resistance of that portion of the circuit consisting of the leads is, in accordance with Ohm's law, equal to the drop of potential divided by the current. This takes into account the whole length of the circuit, or the double distance.

Now, a 16-c.p. 110-volt lamp takes approximately ½ ampere, so that we may write

$$R = \frac{e}{l \times \frac{1}{2}}$$

where R is the total resistance of the leads, and l the number of 16-c.p. lamps. Let d represent the single distance from the generator to the lamps. Then we may divide each of the terms of the above formula by 2d, which will give us the resistance for one foot of the wire, thus:

$$\frac{R}{2d} = \frac{e}{l \times \frac{1}{2} \times 2d} = \frac{e}{l \times d}$$

If we wish to adapt this formula to the three-wire system, we must do so with due regard to Ohm's Law, as already pointed out, and we shall find that the required resistance per foot of the wire will be double that of the two-wire system using lamps of the same current and voltage. Then, for a three-wire system the resistance per foot of the conductor,

$$R = \frac{2e}{l \times d}.$$

As an example, we will consider the following problem: A feeder is required to deliver current for 120 16-c.p., 110-volt lamps, the distance from the generator to the distributing board being 200 ft., and the allowable drop 1.5 volts. What size wire should be used?

The above formula will at once give the resistance per foot of the wire, and

$$R = \frac{2 \times 1.5}{120 \times 200} = .000125 \text{ ohm.}$$

Wire tables give, usually, the resistance per 1000 ft. of conductors, and by reference to such a table we find that No. 1 B. & S. wire has a resistance of .124 ohm per 1000 ft., and will therefore be suitable.

It may here be mentioned that it is always advisable to check any calculation by comparing the results with the Underwriters' table showing the permissible current which the wire may carry. In this case the limit is 95 amperes. Since two lamps are connected in series, and each requires half an ampere, the actual maximum current is $\frac{120}{4} = 30$ amperes.

It is generally sufficient to make the neutral wire equal in size to the outer conductors, as it is then capable of carrying all the current from one side of the system in case of a main fuse blowing. In such an event, which is not very likely to occur, there will be double the fall of potential between the distributing board and the lamps, because the distance still remains the same while the e.m.f is halved. This is not a serious matter, and the condition would not last long, so that it is not necessary to guard against it. However, the neutral wire may be made twice the cross-sectional area of the outer wires, in which case the drop of potential is 1½ times that of the three-wire system when one side is disconnected. The chief advantage of such an arrangement is, that the two outer wires may at any time be connected together and the larger wire be used as a common return for a two-wire system.

The actual saving in wire by the use of the three-wire over the two-wire system is one-fourth when the neutral is made the same size as the outer wires, and when an equal drop is considered. For an equal percentage drop, however, which is actually a larger drop with the 220-volt circuit, the wires are smaller, and a saving of five-eighths is obtained in the weight of copper.

## AMERICAN TELEPHONE PRACTICE.

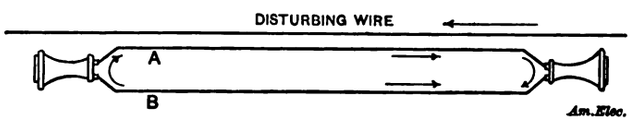
### LINE DISTURBANCES.

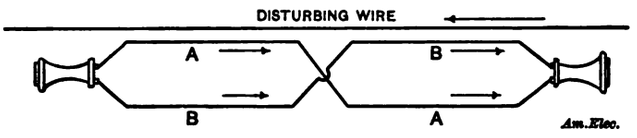
BY KEMPSTER B. MILLER.

The one remedy for all the troubles due to disturbing noises from any of the causes is to make the line a complete metallic circuit. Even this will not completely stop noises from most of the causes, and all additional precaution must be taken, by making the two sides of the circuit alike in all respects and properly transposing them at frequent intervals, in order that they may be as nearly symmetrical with respect to the disturbing source or sources as possible.

Merely making the line a metallic circuit, as in Fig. 1, does not give complete freedom from inductive troubles from other wires, whether the induction be electromagnetic or electrostatic. Considering the question from the standpoint of electromagnetic induction, a current flowing in the disturbing wire would set up a field of force, the lines of which would cut conductors A and B. A being closer, however, would be cut by more lines than B, and consequently any currents induced in A by changes in this field will be stronger than those in B. If a current starts to flow in the disturbing wire from right to left, as shown, the induced currents in A and B will each be from left to right, as indicated by the arrows. These currents will partially annul each other, but that in A, being the stronger, will predominate, and the resultant will flow in the circuit in a direction indicated by the small curved arrows.

A single transposition in the center of the metallic circuit will completely annul the electro-magnetic induction if the disturbing wire is parallel to the two wires throughout its entire length, and if it carries the same current in all its portions. Here an impulse in the direction of the arrow in the disturbing wire (Fig. 2) will cause impulses in the opposite direction in both wires A and B. As the average distances between the disturbing wire and A and B, respectively, is the same, the strengths of the induced currents in A and B will be equal, and they will, therefore, annul each other, producing no sound in the receivers.




FIGS. I AND 2.—ILLUSTRATING LINE DISTURBANCES.

It is found, however, that a single transposition in the center of the metallic circuit will not free the line from cross-talk, even though the average distance from the two wires and the disturbing wire is the same, and the current strength is uniform throughout the entire length of the disturbing wire.

Mr. Carty's experiments throw much light on this point. In Fig. 3 is shown a disturbing wire and a metallic telephone circuit composed of two wires, A and B, of which A is nearer the disturbing wire than B. At a time when the charge on the dis-

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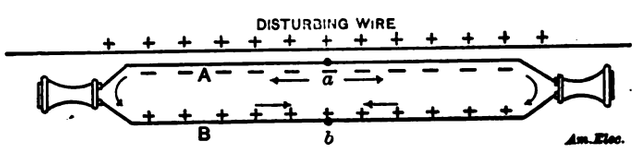
turbing wire is positive, as shown, a negative charge will be drawn by it toward the disturbing wire and a positive charge will be repelled from it. The result is that the distribution of charges on the two wires, A and B, will be somewhat as shown, a negative charge being held on the wire A and a positive charge driven to the wire B.

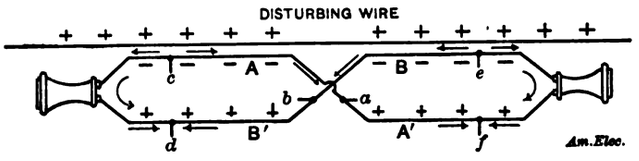
In order for this rearrangement to have occurred it is evident that a flow of electricity must have taken place from A to B, and as two paths were afforded from the center point a, on the wire A, of equal resistance, this flow must have been from that point in each direction as indicated by the arrows, through the receivers and toward the center point b on wire B, where the two currents met. Upon the charge on the disturbing wire becoming zero the potentials on A and B become equal, by a flow of positive electricity from the center point of wire B to that of wire A. The negative charge on the disturbing wire, which follows the positive charge, will cause this latter to flow from b to a to continue until A is positively and B negatively charged.

It is evident, therefore, that alternating currents flow through two receivers, and that these currents differ in phase from that in the disturbing wire by 90 degs., which is characteristic of the action of condensers. Further consideration will show that the points a and b are neutral, and experiment bears out this conclusion, for by opening the wires at those points the sound in the receivers at the ends still continues.

Where receivers are connected in the circuit at a and b no sound is heard on them, although plainly audible in the end receivers. A single transposition in the center of the line, as shown in Fig. 4, will tend to reduce the sound in the end receivers, but will not cause silence. The static charges on the portions of the wires nearest to the disturbing wire now find four paths instead of two to the more remote portions of the circuit, the flow being clearly indicated by the arrows. The center points a and b are no longer neutral, and receivers placed in the circuit there will be subject to noises.

It is evident that if receivers of equal impedance to those at the ends of the line, were placed at a and b, the neutral points c, d, e and f would be found at the quarter points on the line; i. e., midway between the transposition and each end. As a matter of fact, however, no instruments are placed at the point of transposition, and the neutral points are shifted toward the ends of the line, because the impedence of the receivers at those points makes it easier for most of the current to pass through the transposition wires. Theoretically, the currents set up in a metallic circuit by electrostatic induction from another circuit can be eliminated only by making an infinite number of transpositions. Practically, however, it is found that on long circuits transpositions every quarter or half mile are amply sufficient to render them unnoticeable.




FIGS. 3 AND 4.—ILLUSTRATING LINE DISTURBANCES.

## THE ELECTRIC LIGHT AND POWER SWITCHBOARD.

BY S. H. SHARPSTEIN.

The switchboard question is possibly as difficult as any the engineer and superintendent has to decide upon. It is very essential to so design and construct it that it will never cause the circuits it controls to shut down, especially when the greatest number of lamps are burning.

If a generator breaks down another can be put in its place; but if an arc occurs on the switchboard the machine or machines that feed the arc will keep right on working, as a rule, until the board is ablaze. Built as some modern switchboards are, with rubber covered wire, and in many places sheet hard rubber being used, when once a blaze is started destruction is quite sure to follow.

One of the most peculiar things in modern electrical work is the way fire underwriters will drive the electric lighting and power people from one position and sometimes let them take up another much worse than the first. Some of the modern boards, with complicated switches breaking high-voltage circuits, are sure sooner or later to cause fire, since so much highly combustible insulation is present to burn.

High voltage wires are placed close to each other, and for safety the insulation is depended upon. After a little time dust and dirt accumulate, and when the switches, hemmed in by the wires, get somewhat worn and burned, fire is likely to occur. This applies more particularly to the alternating current boards that are being installed in many stations.

The popular method is large units and but few circuits. This being the case, each machine or circuit panel of the switchboard controls the current for a large district. The income that is influenced is necessarily large, hence it is economy to leave ample space for such panels and to design and construct them with care.

Wood has been discarded for fronts; slate is used only for low voltage boards; marble is almost exclusively used for high voltage boards because of its higher resistance. With a pressure of two or three thousand volts, the darker marbles are best because they do not show the dirt so plainly.

When it is understood that a slab of white marble can be badly discolored by laying it on a clean pine stick, where it will absorb the oils from the wood, or by allowing it to come in contact with anything that will impart lubricants to it, it is easily understood why such marble should not be used for a switchboard unless it is to stand in a clean place and be cared for by a competent person. Many times grease and even oil is used on the working parts of a switch, and therefore it is an easy matter to get them on the marble. Because of the higher resistance of the white marble it is very much used, where the darker grades are prohibited because of their lower resistance.

Sooner or later all apparatus on the board will have to be removed for repairs; therefore the designer should bear in mind the desirability of having the board constructed so that each slab containing apparatus be arranged to be removed with ease. Each panel should contain a number of slabs unless there are no busbars and wires in the way of making repairs. Breakage is liable to occur in shipping, and small slabs are more easily replaced.

As a rule, it is not customary to run alternators in parallel; for this reason the board should be constructed so that each machine can be easily connected or thrown onto any circuit leaving the station, or so that all the circuits can be worked from one machine when the station load is light. The switches and cables should be so arranged that it will be impossible to short circuit any machine while switching at the board.

When a generator is working on one circuit, it is easy to vary the pressure somewhat by means of the exciting circuit as the drop in the line increases or decreases, but when two or more circuits are run from one machine, it is essential that each circuit should have some method of varying its voltage independent of the machine or other circuits; therefore it is necessary that every circuit panel have a voltage regulator.

If the generators be single phase, each circuit panel should have a double-pole, double-throw switch with ample jaw contact to keep from heating and with sufficient break to keep from arcing if the circuit it controls be crossed. When the voltage gets high it takes quite a large switch to have break enough to open the circuit under the above conditions, without excessive arcing, but all devices for cutting off or blowing out an arc are apt to become a nuisance on a switch sooner or later, and should not be adopted without close consideration.

If cities could be lighted with a pressure at the machine and on the mains of ten volts, the damage to station apparatus when a cross occurred might be slight. As the conditions outside the station develop in complication, the chances for crosses from main to main increase. With very

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high voltages such crosses are very often disastrous, especially when close to the station or generator. The only good feature about a fuse is its cheapness of installation; experience has demonstrated that, as a rule, it is out of place in a generator circuit on a switchboard.

In an easily accessible position may be placed, on each circuit panel, an automatic circuit-breaker. As in the main switch for high voltages, both legs of the circuit ought to break with a gap amply large to open the maximum current without any complicated apparatus to cut off the arc. The blades and jaws for carrying the current must be guarded from being burned by arcing, as such burning causes the blades to hang in the jaws when the switch should open. A good spring is the most convenient for throwing a circuit breaker switch, and the lever by which the switch is closed and spring set should work through a long arc so that the manual working of the device will not be difficult. There is no reason at this day for installing any breaker that will not work at once at the amperage for which it is set, whether at the time of adjustment or one or two years later. One requirement of vital importance to the safety of the board is to have the breaker positive when the blades leave the jaws. A slow movement is sure to cause arcing and burning.

Often a cross will occur, operate the breaker and at the same instant burn away so as to clear the circuit sufficiently for working. At such a time, if the breaker switch is replaced immediately, the cessation of light is short and of no importance. The practicability of such apparatus is then apparent. On another occasion the cross might stay on, the attendant would, as before, take hold of the breaker lever and replace the breaker switch; before he would have time to realize what was taking place much damage might be done by his holding the breaker switch closed. It follows that a circuit breaker should be so constructed that when the switch is closed on a short circuit it will open again independently of the breaker lever. Occasionally a cross can be burned off, especially with overhead construction, where one wire may touch or fall across another.

Every machine panel should contain an ammeter to indicate the quantity of current the machine may be generating; also a voltmeter to show the voltage of the current. There was a time when it was thought that cheap indicators were good enough for this purpose, but experience has proven that looking at an instrument and then making a guess is not a good method to adopt where dividends are desired on money invested in incandescent lighting. Accurate and dead-beat voltmeters only should be used. A voltmeter that is not dead-beat is only a snare when there is trouble on the circuits or with the machine and the switching must be done in a hurry.

One question of vital importance is the illumination of the board; the attendant must read his instruments, and the light should be so arranged that he will not be compelled to look at a glowing filament. Often times a shade and bracket can be placed so that the only light seen by the attendant is that reflected from the face of the switchboard or the instruments. This is much to be preferred. A good way is to have the instruments all made with the divisions on a porcelain face behind which can be placed a small lamp.

Occasionally the insulation of a generator will become broken down. Every machine panel should contain a detector to remain connected and indicate a cross to the frame just as soon as it occurs, and as long as it remains. One detector for a number of machines and the manipulation of a switch to hunt for breakdowns of this kind is not to be recommended.

It is just as essential that every circuit panel be provided with a reliable instrument to show at once when a cross to the ground occus. Every circuit panel should also have a good volt and ammeter. Some superintendents place on each circuit panel a reliable recording wattmeter, which is essential where a close watch is kept on the economic action of boilers and engines; it also helps to detect any great error in meters outside the station where all the current sold is measured.

Where generators never run in parallel it is quite essential that the busbars of each machine should run back of each circuit panel. It follows that each leg of each machine circuit has got to be connected to each circuit panel. If the generators be small, often there will be a great number of switches, usually plug switches, on the face of the circuit panel. The expense of a number of these plug switches sometimes influences the purchaser to get them poorly designed and constructed. The result is a constant source of trouble and annoyance.

When cables are used, the plug switches should be secure from being loosened by one cable raking over another when the switchboard attendant is working in a hurry. They should be so strong that a good hard thrust from a nervous attendant cannot break them.

Many times all the exciter switchboard apparatus, in stations where alternating apparatus is used, is put on the machine panels; but it is better practice to have a separate panel, just beside the machine panels or on the opposite side from the circuit panels, for the exciters. If but one set of exciter bus-bars is used, on this should be placed an ammeter and double-pole knife switch for each exciter circuit, a rheostat and switch for the fields of each exciter, and a voltmeter in circuit with each exciter to enable the attendant to get the proper voltages before connecting with the bus-bars. One voltmeter with the necessary switch would answer for all the exciting machines. The proper method of installing this apparatus is not an easy problem. It seems like a waste of space and energy to run a small machine with its belts for each alternator. This is the more independent way, but it is not good engineering in large plants.

When all the exciters feed into a common bus system and the large generators are fed from the same, the breaking down of one exciter can often be bridged over by the remaining exciters doing the extra work for a time. Then again if there be trouble with one exciter it is apt to so overload the others that the whole system of machines might be short of exciting current until the disabled machine was cut out. With large exciting machines and proper circuit breakers this trouble could possibly be avoided. Where one set of bus-bars is used it helps to simplify the backs of the machine panels by having only one circuit from which to take the current for exciting the alternators. Whether the exciting current be taken from the individual exciter or from a pair of bus-bars, it should be controlled by a knife switch on the face of each machine panel. Each machine panel should also contain a rheostat connected into the field circuit of the alternators as it leaves the exciter bus-bars.

It is necessary to place upon each machine panel a switch of ample carrying capacity so as not to heat with the maximum current, and to break any current that it is possible for the machine to generate at full speed and on short circuit. As with the automatic breakers and main switches on the circuit panels, so these switches should break each leg of the circuit in at least two places. All the above mentioned manual switches should travel independent of the operator after the blades have left the jaws. Good designing and workmanship will produce a switch that will be actuated by a spring in such a way that the initial travel of the blade will be very rapid and tend to break the otherwise produced arc.

## TELEPHONE PARTY LINES.

WHITTEMORE-BARRETT-CRAFT SYSTEM.

BY H. S. WEBB.

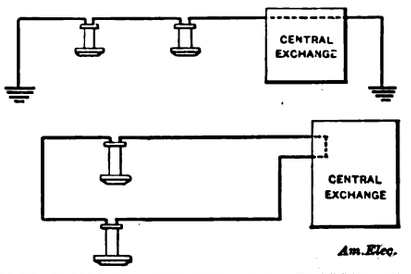
For a long time after telephones came into use it was customary, when economy or other conditions required that more than one telephone should be connected to the same line or pair of lines, to connect them in series as shown in Figs. 1 and 2. Whenever two or more telephones are connected to the same line or to the same pair of lines it is called a party line system. The above arrangement of telephones has the disadvantage that when the operator at the central station sends a ringing current over the line all the bells on that circuit will ring, thus requiring a distinctive number of rings for each subscriber. Furthermore, when any two subscribers are talking there is nothing to prevent another subscriber on the same line from taking down his receiver and overhearing the whole conversation. When one telephone is in use the bells of all the others remain connected in the circuit, and therefore the number of telephones which can be placed in one circuit and not interfere with the conversation is very limited. Scarcely ever more than four can be used successfully in this way. This arrangement is very apt to give bad service and cause much trouble.

Instead of connecting them, as above, in series, or "looping in," as it is called, a much better plan was afterward adopted,

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that of connecting all the telephones in multiple, or what is known as the "bridging bell" method. Fig. 3 shows the method ot connecting two or more instruments in multiple on a metallic circuit. If they are connected to an earth return circuit then all connections made to line B in this figure would be grounded at each station.

The subscribers' bells being always in




FIGS. 1 AND 2.—GROUND AND METALLIC RETURN.

circuit, they are made of high resistance, about 1000 ohms. The impedance of this bell is so high (about four times its resistance during the conversation when the average frequency of the current is about 300 periods per second) that it does not permit an appreciable part of this current to pass through it, thus forcing practically the whole current through the receiver. The generators are wound to furnish an e.m.f. so low that they will not ring the high resistance bells at the subscribers' stations, but they will operate the low resistance annunciator at the central station. For this reason the generators have a low resistance, and consequently they must have an automatic device which normally leaves the armatures of the generators on open circuit, closing the same only when the handle is turned.

Fig. 4 shows the connections of a "bridging bell" subscribers' telephone set. In order to show more clearly in one diagram the connections of the Warner switch I have altered the detail of the switch contacts slightly, placing one contact spring behind instead of alongside the other. This figure also shows the automatic "cut-in" device for closing the normally open armature circuit. When the handle is turned, a pin on the crank axle slides up the side of a V-shaped recess in the hub of the driving wheel, so drawing the other end of the crank axle away from a spring, the fixed end of which is always connected to one terminal of the armature, and allowing this spring to come into contact with a point connected to the line 1.

Now the generator at the central station is so designed that it can easily ring these high resistance bells. Since the frequency of this ringing current is much smaller than that of the current during conversation, the impedance of the bell for this current will not be much greater than its resistance.

By this arrangement twenty instruments have been successfully operated on one pair of lines, but for various reasons it is not advisable or customary for companies operating exchanges to put more than six subscribers on one pair of lines. However, I know of one case where there are seven on the same circuit, and doubtless there are other such cases.

This "bridging" system has several advantages over the "looping" method. First, a larger number of subscribers can be put on the same circuit. Second, a subscriber when he calls up the exchange does not ring all the other bells on his line. Third, the numerous cross connections between the two sides of the circuit through the high resistance bells tend to free the line from electrostatic charges, so that the circuit is freer from the evils produced by electrostatic induction.

It, however, still possesses two faults in common with the "looping in" method. First, the operator cannot ring one bell without ringing all the others, requiring, as before, a distinctive number of rings for each subscriber. Second, any subscriber can take down his receiver and overhear the conversation between two other subscribers, and he can also interfere with conversations by ringing up when the line is already in use. To obviate these two objections to party lines, several attempts have been made, using various systems of selective devices. The only one that I know to be in successful operation to any extent in this country is the party line selective system patented by Whittemore,

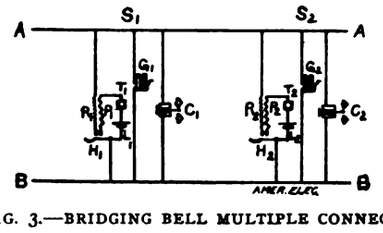



FIG. 3.—BRIDGING BELL MULTIPLE CONNECTION TO SINGLE CIRCUIT.

Barrett and Craft and assigned to the American Telephone & Telegraph Company.

By the aid of the diagram in Fig. 5 the principles upon which the system is based can be readily explained. Let there be two metallic conductors, A and B, between stations C and S, and also a connection to ground at both places, which is practically equivalent to three wires from C to S. It is evident that the following combinations of currents can be sent from the battery L at C to S over the two line wires and the ground.

A current can be sent in either direction over A, using the earth as a return and not using B at all, thus giving two selective signals. Similarly, a current in either direction can be sent over B without using A. Without using E a current can be sent in either direction over A and B in series. A current can be sent in either direction over A and B connected in parallel, returning through E; also, in either direction over A and E in parallel, returning through B; and finally, in either direction through B and E in parallel, returning through A.

This gives twelve different combinations, furnishing means for twelve selective signals. In using either A or B in parallel with E, the return circuit being through B or A respectively, balancing resistances would have to be used in order to make the current divide equally, that is, to properly balance the system, requiring close adjustment, for which reason the last four combinations have not been found to be of practical value. In the accompanying table are tabulated the eight useful combinations:

CURRENT COMBINATIONS.

| | Line A. | Line B. | Ground. |
|---|---|---|---|
| 1..... | + | 0 | − |
| 2..... | − | 0 | + |
| 3..... | 0 | + | − |
| 4..... | 0 | − | + |
| 5..... | + | − | 0 |
| 6..... | − | + | 0 |
| 7..... | + | + | − |
| 8..... | − | − | + |

Fig. 6 is a diagram of connections for eight stations; $S_1$, $S_2$, $S_3$, etc., are the subscribers' stations from which two wires, A and B (the outgoing and return conductors of a metallic telephone circuit), run to the central exchange, at which is located a system of eight calling keys, C, a separate key for calling each subscriber. The dotted line represents the earth return circuit. At each of the eight stations there are two relays, connected in derived circuits or earth branches m and q of the main lines respectively, and these circuits, after passing through the relays, unite and connect to earth at $E_2$.

At each station is a direct-current vibrating bell and battery in a local circuit c, which can be opened or closed at two points, 11 and 12, one at each relay. This local circuit is normally open at either one or both of these points. In order to ring the local bell the circuit must, of course, be closed at both points 11 and 12. R and $R_2$ are the local relays which control these local circuits.

The relays at each station differ either in arrangement or construction from those of all other stations. Thus at station S the line A is branched through a polar relay made responsive to a plus or positive current, and line B through a neutral relay

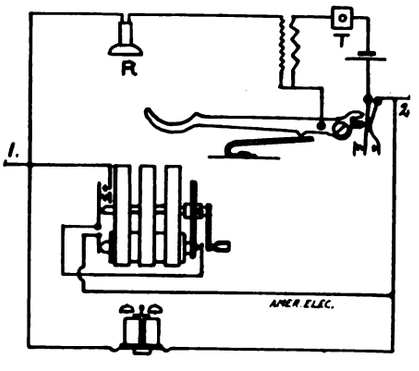



FIG. 4.—BRIDGING BELL CONNECTIONS.

adapted to respond to currents of either direction traversing B. Station $S_2$ also has a neutral relay on B, but a polar relay responsive to a minus current in A. The third and fourth stations have neutral relays connected to A and polar, plus and minus, relays connected to B. The fifth and sixth stations have each two polar relays, one of either sign, but reversed at

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the two stations with respect to the two conductors A and B. Station $S_7$ has two polar relays of plus sign, and $S_8$ two polar relays of minus sign.

The plus and minus signs in the diagrams indicate the direction of current with reference to the central station end of the lines to which each relay will respond. Each polarized relay is arranged to close its own local contact point only when the current in the direction to which it responds passes through it. The neutral relays, indicated in the figure by a $\pm$ sign, on the other hand, will open the local circuits when excited, as they will be by any current, either positive or negative. Thus the local contact points of the polarized relays are normally open, while the local contact points of the neutral relays are normally closed.

At the central station C are located the calling battery or generator G, and the group K of eight circuit-changing calling keys, each key corresponding to the arrangement of relays at some one station. Thus if any key is depressed only such combination of currents is sent over the lines as will operate the local relays of one particular station in such a manner as to close both local contacts, while one or both local contacts at the relays of all other stations remain open. Hence all that is necessary to call a particular station is to depress the one key corresponding to that station.

Depressing key 1, for instance, puts the negative pole of the central station generator to ground through one side of the key, and sending through the other side of the key a positive current over line A, through all the R relays, returning to the central station through the ground. But no current will pass through the $R_2$ relays because line B is left on open circuit at the central station. Thus at S contact 10 will be closed by the polarized relay R, since a current flows through it in the positive direction and 11 will remain closed because no current at all passes through its neutral relay $R_2$. Thus the bell at station S will ring, since its local circuit is closed at both 10 and 11.

Furthermore it will be shown that no other local bell circuit will be closed. For at $S_2$ the polarized relay R will not be

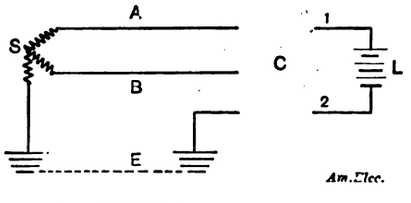



FIG. 5.—DIAGRAM OF PARTY LINE SYSTEM.

operated by a positive current, hence its contact at 10 will remain open. The local circuits at $S_2$, $S_4$, $S_5$, $S_6$, $S_7$, $S_8$ will be open because there is no current through their polarized ($R_2$) relays, thus leaving these relays in their normal positions, that is, with their contacts at 11 open. Thus, the only station called is S. Similarly it may be shown that by depressing key 2 the only station called will be $S_2$ and so on.

The inventors have also designed and patented an eight-station system in which the neutral relays are all replaced by specially wound and connected polar relays. This was probably to prevent any one else doing the same, because in this case the neutral relays are simpler and doubtless much cheaper and more easily adjusted and kept in order than the polar relays.

In a succeeding article, a description will be given of the method for preventing one station from overhearing the conversation taking place between two others.

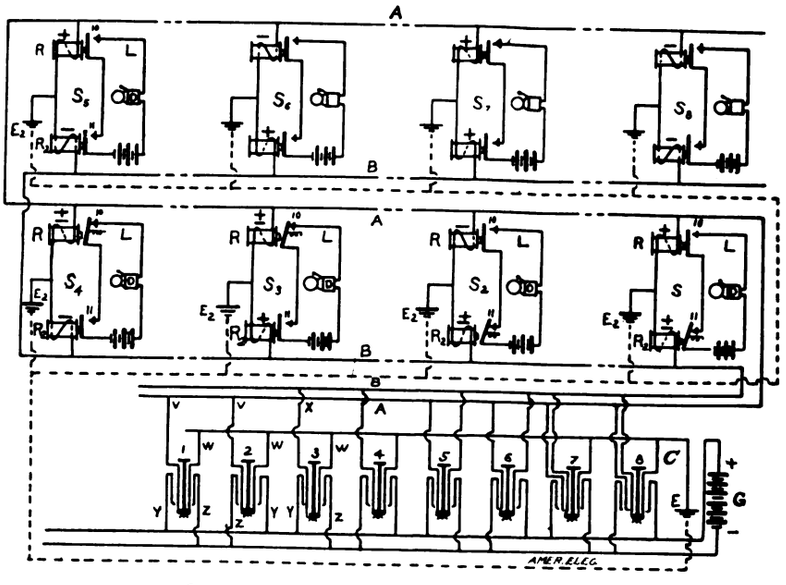



FIG. 6.—DIAGRAM OF CONNECTIONS FOR SIX STATIONS.

## ELECTRIC RAILWAY PRACTICE.

### CAR EQUIPMENTS.

BY WALTER MUNROE.

The parts of a car equipment that need to be looked after are quite numerous—in fact all parts should be examined at more or less frequent intervals. Let us consider first the trolley. The trolley wheel should revolve freely at all times. If the bushing is at all tight and prevents the easy motion of the wheel, there is a sliding action between wheel and trolley wire, which causes unnecessary wear on trolley wire and wheel. They should be examined at least once a day to see that they run freely and are not worn excessively. At the same time the trolley pole should be moved about by its cord to see that it moves freely in all directions. This is important, for if the pole is at all sluggish in following any change in the trolley wire, there is likely to be destructive sparking. This may be particularly noticed if running at a considerable speed where the trolley wire is at all loose between supports. Just after passing each supporting insulator the wheel may be heard to jump, and a flash can easily be seen between wheel and wire. The main wire should be examined occasionally where it is connected to the trolley base.

The hood switches should be looked after to see that they are not loose, and also that the blade and jaws are smooth and make a good firm contact. Upon examining the fuse box, we should see that the fuses are clamped firmly by the contact screws. It is also important to keep out all dust and dirt, as otherwise it may cause a fire when a fuse blows.

There are quite a number of types of lightning arresters in use made by the same and also by different manufacturers. In general it may be said that they should be kept clear of all foreign matter. The later types require less care than the earlier ones. The gap space in the ground circuit should be well looked after.

Coming to the resistance boxes we find a considerable difference among the different makes, particularly as regards protection of the points of connection and exposure of resistances. All the pieces of apparatus that are placed beneath the car floor are bound to be exposed more or less to flying mud and water. So that their protective coverings and also their position determine, to a considerable degree, their liability to give trouble.

In looking after the controller, there are several points which should be kept well in hand. The contact fingers should bear sufficiently hard on the rings to make a good firm contact without undue pressure. Prevent all cutting action and remove immediately all burns that may be formed on the surfaces. The contact fingers should be occasionally moistened with vaseline or some similar compound. All the bearings and interlocking parts should be kept clear and lubricated, but care should be taken not to use too much oil, as it might get on some of the conducting contact surfaces. It can be easily seen that any dust or dirt inside the controller is quite likely to get between the contact fingers and the contact rings on the revolving cylinder. If this happens, there will almost assuredly be destructive sparking or cutting upon their surfaces. Competent men should try the controllers frequently to see that they revolve properly. At the same time they

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should be carefully examined inside, for the above mentioned points. The connection boards should be gone over occasionally for loose contacts.

In considering the motors, it is well to look at them from at least two standpoints; namely, mechanical and electrical. We will first consider some of the *mechanical* features. Some roads use brass or bronze linings for their armature shafts, and if these linings wear unduly, several things are likely to happen. A much too common occurrence is to have the bearings wear down so far that the armature core strikes the pole pieces. Now the armature of a modern railway motor is ironclad and is laminated. The coils lie well inside the slots, and it is the tops of the teeth that strike. When this occurs, the laminations are bent and pushed out of place, closing up the slots, cutting and short-circuiting armature coils, and doing a great deal of damage generally. Very often after such an accident the core will have to be stripped and entirely rewound. This, of course, is expensive. If this occurs out on the road, there is likely to be a long delay for the cars. If there are two motors on the car, the damaged one may be cut out in the controller and the car brought to the repair shop with the remaining motor. Again, the armature may be so damaged that it will not revolve, in which case its axle must be freed in some manner. With some types of motors the armature might be pulled up through the traps in the floor, but a tripod and a tackle would be needed for this, which would mean considerable delay. In any case, removing the gear or pinion will free this particular axle.

Excessive wear on the car axle linings as well as upon the armature bearing linings is quite likely to throw the shafts out of line. If this occurs the gear teeth will be worn unevenly or may even be broken. Excessively worn bearings, in any case, cause considerable play of the shafts, and this will cause excessive noise and jolting of the entire motor. The clearance of the armature cannot be too closely looked out for, as neglect of this point will almost certainly result in ruin to a large part of the armature coils.

The proper lubrication of the bearings is, of course, important. Both grease and oil are used for this purpose. Oil is generally used for the motor doing the heaviest service, and the oil is usually retained by some substance, such as waste placed in the cups. When grease is used, it should be stirred up frequently and the vent hole kept clear. In the winter a softer grease is usually used in order to make up for the difference in temperature. The small channels in the babbitted linings should be kept clear of all hardened grease by occasionally pouring through them a little gasoline, this being *independently* of the regular overhauling of the moters. The nuts on all parts should be kept tight for very obvious reasons. Gears and gear cases should be well looked after to see that there is sufficient grease or oil to keep them well lubricated.

It is well known, or should be, that it is of vital importance to keep the commutator in good condition. It should be covered with a smooth, dark colored glaze and be free from burned spots. It may be treated from time to time with vaseline or some similar compound. The brushes are sometimes treated with a compound that is spread over the commutator as the brush wears down, and this serves as a sort of commutator dressing. Any slight irregularities may be remedied with sand-paper, but when grooved or cut or worn unevenly, it should be turned down in the lathe. If burned spots appear, the commutator should be carefully examined and tested, and the armature coil leads inspected for trouble. Be sure to determine if the fault is due to a loose bar or to crumbled or displaced insulation between bars. The brushes should be pulled up every night to make sure that they move freely in the holders. As the commutator wears down the brush holders should be moved down a corresponding amount so that the distance between the end of the brush and the commutator surface remains always about one-quarter of an inch. A competent man can, by looking at a motor commutator, get a very good idea of the condition of the motor, and he can also tell very closely the care that the motor has had. Keep the brush holder contact surfaces clean, smooth and free from foreign matter.

All the modern motors for ordinary railway work are very completely inclosed. In spite of this, however, some dust and dirt will work itself inside. Now if any of the surfaces are at all moist or oily they will immediately become covered with copper and carbon dust from the inside, and dust and dirt from the outside. This is particularly liable to settle on the inner end of the commutator where the armature leads are attached. It also slowly works itself through or under the protecting heads placed over the armature coils and leads at this end of the armature core. The packing together of this dust at this point is very dangerous, for there is much crossing of leads and considerable differences of potential between them. The chances are very good for the bridging over of one or more commutator segments or for a short circuit among the leads. In either case the commutator is likely to be badly damaged or the armature burned out.

When motors are new and run for the first time, they should be carefully examined at the end of the run to see that neither one is unduly heated. If one is a great deal warmer than the other, the hotter one is probably injured or else it is doing more work than the other. This would occur if its field was weak from any cause.

Maintenance (and this includes inspection) in order to be thorough and of value, must be carried out systematically. That is to say, certain definite rules should be laid down that at a certain definite time intervals certain definite inspections should be made. For example, trolleys and trolley wheels, bearings, grease cups, commutators, brushes and accessories should be examined at least once a day. When running his car the motorman should report any unusual noises or behavior of any part of the apparatus.

A very convenient method now used on many roads is to have printed slips to be filled out by the motorman as a report when anything works badly. The printed headings might be: motor, controller, switches, trolley, brake rigging, etc. These slips should be placed where easily accessible, and should be used by the car barn foreman or inspector as a means of saving delay in remedying troubles. The slips should have proper spaces for date, number of car, trip, etc., and a small space for a few remarks. Many motormen, if they see a large space headed "Remarks," would feel in duty bound to fill in with useless or trivial details.

## GENERAL METER PRACTICE.

BY LYMAN C. REED.

The purpose of this article is to deal with the practical management of a modern meter department, and not to give a scientific dissertation on meters.

The management of central stations, in all the details of the art, has become so well defined in all its different bearings and outlines that we pause to wonder at the apparent crudity of present meter practice. The most important feature, after producing electric current at a minimum cost, is to have it accurately measured at the consumer's at a minimum cost to the producer. A carelessly managed meter department frequently means a loss of thousands of dollars, and one that is conscientiously operated but by incompetent men may be even more disastrous in its results. Granting that the best meters on the market are used, a competent engineer with the proper facilities at his disposal is essential to the best results.

The keeping of records, rendering of bills, and all the general work incident to the bookkeeping part of the department will not be dwelt upon at any length, as the art of bookkeeping is so well defined as to need no special explanation. However, a well-devised system of records is essential to accuracy, and we do not wish to be understood as belittling in any measure the importance of this part of the work. As different systems are in vogue in different parts of the country, it is simply necessary to adopt some fixed system of keeping records and follow it in detail.

The object of this article is to deal with the purely electrical and mechanical features encountered in different stages of the work. It is an almost universal feature to use some one of the many forms of motor meters. As these all bear a great resemblance in their general features, we will take the Thomson recording watt meter as a fair sample of the type, and use it to illustrate in general the features of meter practice which we wish to set forth.

The absolute accuracy of a meter under all loads is, of course, the goal at which we wish to arrive, but as yet this has not been accomplished, and we must content ourselves with the most accurate manipulation possible of the meters we have.

The testing of meters to insure accuracy may be divided into two divisions. First,

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testing meters before installation; second, testing meters in circuit to insure continued accuracy.

Testing meters before installation cannot be too carefully done. The very best instruments should be used and a convenient and suitable testing board provided. In this connection, I would like to make a small digression and describe a board suitable for all voltages from 50 to 1000 volts.

With a central station furnishing current to consumers at 50 and 115 volts, alternating; 115 and 230 volts, direct current, and

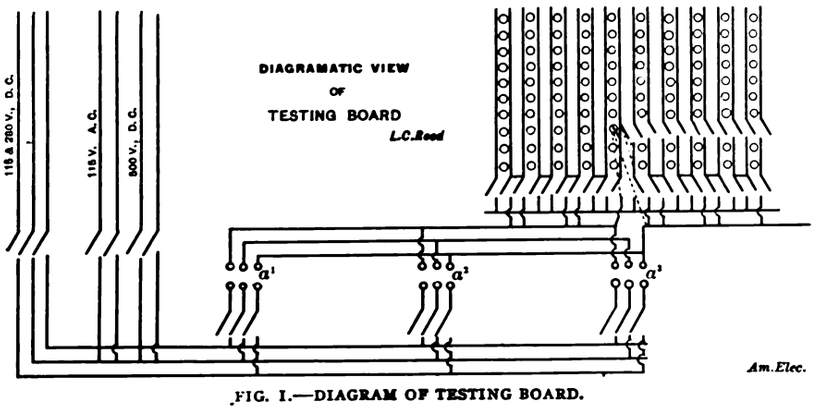



FIG. 1.—DIAGRAM OF TESTING BOARD.

500 volts direct power services, the problem of using one lamp bank on testing board for these different voltages became an interesting one, and was solved as shown in the accompanying diagram and photograph, the latter giving a view of the front of the board. The board and bench are of white marble, the board being 8 ft. x 8 ft., with the lamps and all wires on the back, switches and instruments on the front. By employing single-pole switches and making the "risers" for the lamps the same potential in between the rows, no difficulty was experienced in adapting the lamps to any of the voltages given. The diagram of connections and photograph will readily show how the board is operated. Nevertheless, a few words in explanation may serve to make it clearer.

The lamp bank consists of ten rows of lamps, five rows on each side of the three-wire system. The board is provided with a connecting switch, so that all the lamps can be used on 115 volts either alternating or direct. To burn a bank on 500 volts, the switches at the ends of each five rows are closed and all the intervening switches opened; then by having risers tapped permanently together, as shown, the five rows are put in series.

The throw-over switch also enables all lamps to be burned on 500 volts. The five rows at the right of the board are broken by a row of single-pole switches, so as to enable any number of lamps being turned on without resorting to unscrewing the lamps. This arrangement also allows of three different loads being obtained for 500-volt circuit.

If at any time it is desired to burn a bank on 1000 volts, the end switches are closed and tie-over switch put in, all other switches being opened. It will then be obvious that all ten rows of lamps will be in series. Of course, it is understood that only one kind of current can be used at a time. The other connections are sufficiently plain to warrant no further explanation.

The instruments consist of a 500-volt voltmeter, scale 250 to 600 volts; a double scale 115 and 230 voltmeter, direct current; a double scale ammeter reading from 0 to 10 in 1/10-amp. divisions, and from 0 to 50 in ½-amp. divisions. All instruments are of the standard Weston station type, illuminated dial.

I merely point to this as a sample of testing board, which, after a year's service, is found to fulfill the many demands to which it is put. No alternating instruments are shown, as we only have the portable type.

An absolutely steady potential is essential to correct testing, and leads direct from the storage battery should be taken to the testing board. Where no storage battery is in use, one especially for the purpose should be obtained, as the absolute accuracy obtainable will more than pay for the cost. The instruments used in testing should be calibrated frequently by any of the best methods in use, so as to eliminate all errors due to this source. Meters should be tested particularly for light load accuracy, as well as overload accuracy, and the best possible adjustment given them. While great stress has been laid upon overload accuracy, too much cannot be said in favor of having meters correct on small load. The major part of the station's income is registered on from 5 to 20 per cent the rated capacity of the meter.

To bear this statement out, we will cite a probable modern plant of, say, 100,000 16-c.p. lights or equivalent. In the plant itself there would be not over one-third this amount in engine capacity, while the mean load line would be not more than one-third of this amount, or one-ninth of 100,000 lights would represent the mean load line for the twenty-four hours. The capacity in meters would be fully 75 per cent of the 100,000 lights, or 75,000 lights meter capacity. The mean number of lights burned would therefore be 11,000, or 14.7 per cent would represent the average working load of the meter. Hence it can be seen how essential it becomes to have meters correct on light loads, as well as overloads.

The above gives the general average. There are, of course, special cases where meters work under better conditions. On large installations, where the the total number of lights is only burned for a few hours during the day, a meter of sufficient capacity to carry full load will be found to be very slow on from 1 to 15 per cent of this load. In a recent article in the AMERICAN ELECTRICIAN a parallel switching arrangement was described, which gives the highest attainable accuracy under all loads, and is especially adapted to all consumers that use a small amount of light in the day time and small all-night burning.

The selection of meters for installations should be a subject of careful consideration, and the special conditions prevailing studied, so as to put in as small a meter as possible without endangering the complete destruction of the meter by overload. It frequently is better practice to burn up a meter than to put in one so large as to be very inaccurate on the consumer's usual load. A load curve of the consumer's burning, if conveniently obtained, would be of great assistance in this connection. The placing of meters, therefore, becomes

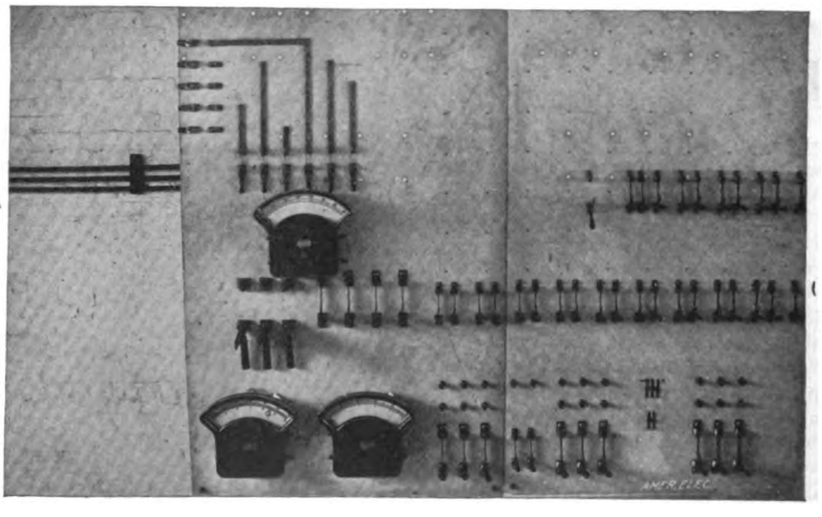


FIG. 2.—TESTING BOARD.

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a subject for the exercising of nice judgment, for which no definite rule can be laid down, but the matter must be decided by the exigencies peculiar to the case in hand.

Before taking up the subject of testing meters on the outside, it might be well to say a few words about repairs. The repair room should be fitted up with workbench and vise, and also supplied with all necessary tools needed in repairing meters. A good mechanic should be obtained, and all repairs can be made except the actual making of parts, which can be more cheaply obtained from the manufacturer.

Any number of unserviceable meters that would otherwise have to be shipped back to the manufacturer can be repaired and put in perfect order. The meters repaired are given a rough test by the repairer before sending to the testing room. The final test should only necessitate the careful adjustment of the meter. The changing of meters from 50 to 100 volts, or any other changes are all made here, and a fully equipped repair room will be found by far the cheapest way of keeping meters in repair. All cut-off meters and meters changed for inaccuracy are sent to the repair room, thoroughly cleaned and renovated and placed in the testing room for final adjustment. It is often found necessary to get up some special arrangement connected with meter operation, and the presence of a skillful mechanic is a great help in cases of this kind, and often saves the expense of getting the work done by some model worker.

In a following article will be considered the subjects of keeping meters in perfect condition after they are installed, and also special tests demanded by consumers or thought necessary by the general manager.

## STEAM AND WATER STOP VALVES.

### GATE VALVES.

The value of a good stop valve is not always appreciated by station managers or engineers, until they have at some time or other had an experience with inferior or worthless fittings of this class. In fact, possibly few people realize that no steam plant yet installed could be operated without the stop valve in great quantity and variety. Many station managers appreciate the valve and allow its full importance to be set forth at once. For buyers of this class there are many excellent valves in the market for which a fair price is asked. For the other class of buyers I am sorry to say that there are valves also, and valves that can be bought for less money than the good ones.

It usually needs but one experience of this kind to teach the engineer his lesson, but when the manager does the purchasing he does not always get the experience, and so continues to receive inferior fittings upon the mistaken score of economy, and thus in fact gives to the engineering department the dearest fittings he can buy, instead of the cheapest, as he thinks he is doing. But there is another side to the story. No matter how good a valve may be it is possible—yes, it is quite easy—to spoil it the first time it is closed under pressure. A very small bit of dirt—a fragment of iron from a pipe thread—will, if caught on the seat when the disc is screwed down, so cut into the working parts of the valve that

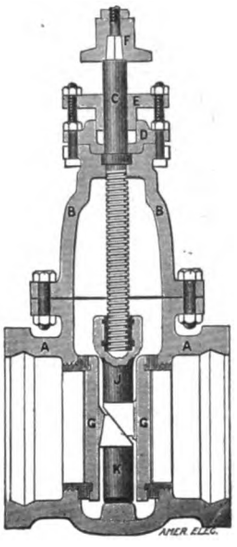



FIG. 1.—LUDLOW DOUBLE-GATE STRAIGHT-WAY VALVE.

a channel will be scored across the seat, and never more can that valve be made tight again until the damaged parts are repaired or renewed.

It is here that the unskilled handler gets in his work of destruction alike on the best and poorest of valves. If he screws down a valve after it is evident that some foreign substance is caught on the seat he will surely cut the seat or disc—and the unskilled man always does this. If the valve does not close tightly he puts all his strength on the hand wheel and forces the seat and disc together if possible.

Although the solid metal-to-metal surface valve is the best and most reliable under skilled handling, the very fact that there are unskilled and careless valve handlers has led valve makers to adopt all manner of expedients to prevent damage to valves as above described. To this end have been invented all the soft and removable discs, the flexible seats and elastic working parts. Thus they are all makeshifts designed to enable cheap labor to be utilized in places otherwise impossible to use it. I call attention to these points to aid in a solution of the problem why some engineers work with inferior valves while others of that class spoil even the best valves that are placed in their hands.

Valves are divided into two great classes, globe and gate, between which the honors are about evenly divided at the present time. The globe is the oldest form, and was the most popular type of valve until quite recently. Now the two forms are about equally used, with a strong and constant increase in favor of the gate valve, which possesses certain inherent advantages that may make it the valve of the future as soon as the constant improvement which it is now undergoing has led it to practical perfection.

The first gate valve was a very crude affair, not at all like the finished ones of the present time, an excellent type of which is shown by the accompanying engraving, Fig. 1. This valve, the Ludlow, is so constructed that the internal mechanism consists of the stem, two gates and two bevel-faced wedges, the wedges being entirely independent of the gates (or discs) and working between them.

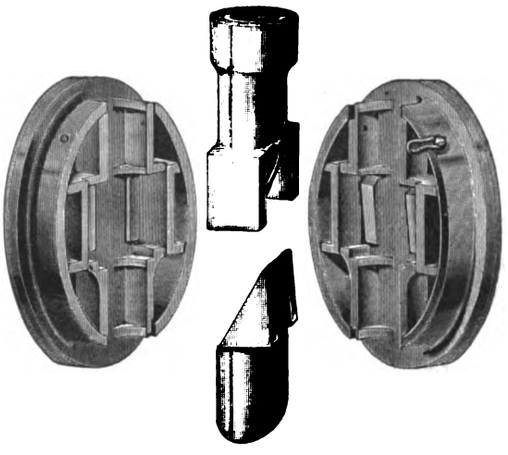


FIG. 2.—GATES AND WEDGES FOR DOUBLE-GATE VALVE.

By the action of the stem, C, which works through the nut, J, in the upper wedge, the gates descend parallel with their seats until the lower wedge strikes the stop (or bolts), K, in the bottom of the case—the gates and upper wedge continuing their downward movement until the face or bevel of upper wedge comes in contact

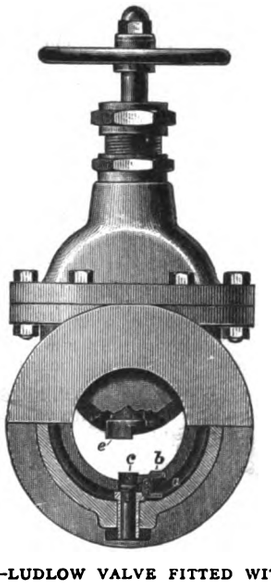



FIG. 3.—LUDLOW VALVE FITTED WITH AUTOMATIC DRIP.

with face or bevel of lower wedge. The gates then being down opposite port or valve opening, the face of the upper wedge moves across the face of the lower wedge, bringing pressure to bear on the backs of both gates from central bearings, thus forcing them apart and squarely against their seats.

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In opening the valve the order of things described above is practically reversed, the first turn of the stem releasing the upper wedge from contact with the lower wedge, thereby releasing both gates (or discs) from their seats before they commence to rise. This removes all, or nearly all of the grinding which formerly damaged the gate valve at opening and closing, at which time the gate or disc had to be drawn off the seat while under pressure. The construction also allows the valves to work equally well with the pressure on either side of the gate. The gate rings, n, n, are easily removed when necessary, and the case rings, t, t, are also screwed into the main casting of the valve body.

These valves are also made, when so desired, with an automatic drip which will drain the valve chamber alone, or the entire connecting tube if so desired. Fig. 3 shows the construction and manner of operating the drip. The stem, c, forms the controlling connection with the valve

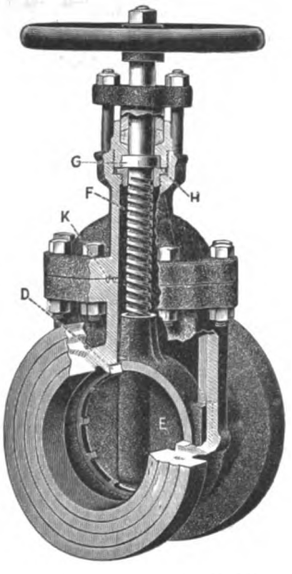



FIG. 4.—THE VICTOR VALVE.

which drains the cavity a. The mechanism b serves to make connection between the dip valve stem and the main valve stem, e, so that the final turn in closing the valve opens the drip. When the valve is to be opened the first turn closes the drip, which then becomes disconnected from the main stem.

A single gate valve of the same manufacture is for use under low pressures, or otherwise where double gate valves are unnecessary. In this valve the pressure comes against the back of the gate. The seat ring is screwed in, and the gate valve is dove-tailed and riveted on, while both rings have ground faces, thus making a steam and water-tight joint.

Fig. 4 shows another form of gate valve, made by the Lunkenheimer Company, and known to the trade as the "Victor" valve, the seats and discs of which are so made that they can be renewed when worn without the necessity of taking the valve body from the connecting pipes.

The discs in these valves are all made to standard tapers so that they are interchangeable. The seats are finished separately from the valves and faced off straight. The recesses in the body which receive the seats are threaded exactly to the angle of the taper on the disc, and when the seats are secured in place they fit accurately to the disc. This method is

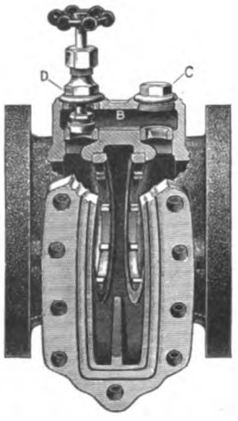



FIG. 5.—VICTOR VALVE, WITH BY-PASS.

claimed to be superior to facing off the seats after they are secured into the body, for the reason that this latter method does not permit of renewing the seats when they are worn; and should the seats become slightly unscrewed, the integrity of the bearing between them and the disc would be impaired, causing the valve to leak. The seats and disc are both made of hard phosphor bronze so as to insure durability and reduce to a minimum the cutting action of the steam on the same.

In order that the stuffing box of the valve may be repacked under pressure, the disc is made so that when raised it makes a joint in the hub so as to keep the steam from leaking out at the top.

The joint between the hub and body is formed by two seamless copper wire washers, which are imbedded in the top surface of the body, and the hub when screwed in place forces them down, thereby forming a joint which is practically indestructible.

The method of by-passing employed by the manufacturers of "Victor" valves is

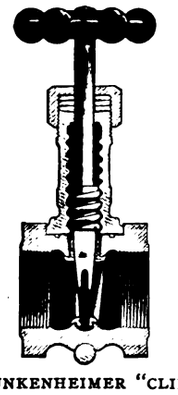


FIG. 6.—LUNKENHEIMER "CLIP" VALVE.

quite novel and possesses features of merit. As will be seen in Fig. 5 herewith, the by-pass instead of being formed externally consists of a cored passage which leads around the disc and has two valve seats, only one of which is intended to be in use at a time, the opening to the one not in use being closed by a plug. Should the seat of the valve in use become worn or leaky, the position of the valve trimming and plug can be reversed, thus making use of the reserve valve seat, and the worn one can be renewed and reground. The principal advantage of this style of by-pass is that it is entirely self-contained, and is not affected by extremes of expansion and contraction. When it is desirable to cover the exterior of the valve with some non-conducting material this can be done very easily.

The "Clip" gate valve, also made by the Lunkenheimer Company, is intended for use when pressure does not exceed 100 lbs. per square inch. The hub is secured to the body by a V-shaped clip which passes around the body and through lugs in the sides of the hub and holds the same firmly to the body by means of two nuts. This construction is very convenient when it is necessary to take the valve apart for examination or repairs. The joint between the hub and body consists of a seamless copper wire washer, which is firmly imbedded in top part of body and forms a joint against the upper side of hub when the same is in place. The disc has two seating faces, and takes pressure from either side. The stem has a coarse thread which makes it possible to open or close the valve very quickly. The stuffing box on the small sizes has a special packing arrangement to prevent the same from working loose.

## ECONOMY OF STEAM PRODUCTION.

BY A. L. HARRISON.

As the economic production of steam is independent of the application or use of steam, in considering the possible economies in producing steam, I shall, therefore, consider only the boiler and appurtenances, and boiler-room practice.

Boiler-room practice too often represents principally an outfit more or less wisely selected and left to the varying whims of the fireman—the engineer seldom being seen in the boiler room, except when steam is short, and then he comes to ask the fireman, "what is the matter?" The modern progressive engineer, however, takes charge of the boiler room as completely as of the engine and dynamo room. The firemen do their work as his assistants and under his direction. He makes the necessary visits and observations to know the conditions and practice in the boiler room. It is true that in too many cases there is little or no appreciation on the part of the employer, but an engineer should have some self-respect to maintain; enough professional dignity and pride to put at least a good degree of conscience into his work, for the work's sake, even though proper appreciation on the part of the employer or superior be lacking. Intelligent, constant supervision of all the details of boiler room practice is necessary to secure the best economy.

There is, however, many cases where the boiler and its appurtenances and arrangement, one or more, or all, are such as to preclude the possibility of securing the

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best economy. In such cases it requires a wise, faithful engineer to realize the best practicable economy.

The encouragement of an improved, progressive practice is what is wanted. And since there are few (I know of none—no, not one) ideal boiler plant, it is necessary to discuss the best methods for securing economy in the average plant as it stands, as well as how to secure an ideal plant.

I find in most plants boilers that are not best suited for the work required. The units are either too small or too large, or the total capacity too small. The latter is a very prevalent difficulty, and one which represents serious difficulty to the competent, conscientious engineer. The duty must somehow be secured, even if risks must be taken involving possible serious damage to both property and life. "We must have the steam; if you cannot get it we must secure an engineer who can," is the practical situation confronting too many engineers, and the usual consequence is a waste of fuel, if, happily, no more serious results follow.

But there are many cases of waste which might be abridged if the best practicable use were to be made of existing appliances. Some engineers make the mistake of clamoring for a new style of boiler. There is no fact more thoroughly established by experience than that there is little in the economy that can be realized under like conditions, from one type of boiler over another, so far as the standard types are concerned. By standard types I mean those types which are in such general use as to have become commercially established. Even the common return tubular or fire tube boiler can, within the limit of a safe steam pressure, hold its own with the best water tube boilers, especially if the comparison cover a considerable period of service. This latter cause is true because of the fact that the heating surface of a common horizontal multitubular boiler can be more easily kept clean on both the water and the fire side.

There is a vast amount of waste of fuel due to dirty boilers, and the greater part of unnecessary waste from this cause, especially in the use of water tube boilers, is due to the fire side of the tubes becoming encrusted with soot commingled with the fine ash carried to them by the draft, and other products of the fire, which in the furnace heat becomes gasified and subsequently, when cooled by contact with the water surfaces of the boiler, return to a solid form, and lodge on or adhere to the tubes.

Authorities, I believe, unanimously agree that an eighth of an inch of coating of soot and ash on the outer surface of a water tube wastes more heat than a quarter inch of scale on the inner or water surface of the tubes. No one of sense would think of running a boiler with a quarter of an inch of scale on the inner surface. The waste of fuel in such a case is made the more emphatic and receives more prompt attention because of the danger of damage to the boiler by burning or blistering the tubes.

There are not a few so-called first-class plants where a complete cleaning of the outer surface of the heating surface of the boilers would result in decided increase of capacity, as well as desirable economy of fuel per h.p. of steam produced; *i. e.*, per 34.5 lbs. of water evaporated from and at 212° F.

A superintendent of a manufacturing establishment, where three water tube boilers of 350 h.p. each (rated capacity) are required to give a maximum of 1500 h.p. in daily work, recently told me that when he had managed to clean the outer surface of the tubes more thoroughly than by the usual method of "blowing," he found a saving of from three to five tons of coal per day of twenty-four hours.

Another instance is of increased economy and of increased capacity from attention to smoke flues and passages from furnace to chimney, of which I have personal knowledge. In a plant of twenty-four common horizontal tubular boilers, the manager found the coal and the labor bill had increased in much greater ratio than his product, and that it was with great difficulty that the necessary capacity was secured. On investigation, the blazeway back of the furnace was found to be badly choked with accumulated cinders, ash, etc., and, following up this revelation, found the flue passages from boiler to chimney also badly choked. After all had been thoroughly cleaned, they dropped off four of the boilers used and reduced the coal consumption from seventy tons per twenty-four hours to forty-five tons; dispensed with five men formerly employed in the boiler room, and had no difficulty about enough steam.

The coal had been wasted at the rate of about twenty-five tons per twenty-four hours (over thirty dollars per day) through negligence or stupidity, because the engineer in charge had not given proper attention to details in the boiler room. There is another engineer in charge now, and results are quite satisfactory.

Another case which recently came under my observation was in the case of a large steel mill using boilers aggregating about 8000 rated h.p.; I had some time previous recommended an increase of at least 1000 h.p. to obviate the necessity of crowding beyond the economic rate of duty, but cost of installation kept the enlargement in abeyance. At the time referred to, I chanced to be there with a pyrometer, and, at a time when the rate of duty was slightly below the usual maximum, I tested the escaping gases, and found the pyrometer registered 685 ° F. The point of insertion of pyrometer was fully three feet from where the gases left the boiler, and through the upper side of a flue having a down draft, and near where the downward turn toward chimney occurred. It is, therefore, certain that the flue gases leave the boilers when in full regular duty at not less than 700°. A test of one battery under, as nearly as practicable to determine, average rate of duty showed the boilers were being worked at from 80 to 100 per cent above the rating. As all but one battery, and at times all but one boiler, in that room of about 4000 h.p. were in constant use, no cleaning of the outer or fire surface more effective than "blowing" had ben attempted.

If 2000 h.p. were to be added to that boiler plant, which, with cost of necessary extension of boiler rooms, would require an investment of perhaps forty thousand dollars; the grate surface under the present boilers cut down to suitable proportion, and the outer, as well as the inner side of heating surface of all the boilers kept clean, the work now done could be more easily accomplished; the life of the boilers and of the furnaces prolonged, and a saving could be effected of at least forty tons of coal per day, which is now, and has been, daily thrown away in excessive waste of heat carried away with the escaping gases up the chimney.

The saving in dollars and cents in such a case depends on the price of coal, and I have not sufficient data to set it forth in detail, but have no hesitancy in venturing the assertion that in this plant a suitable increase of capacity, suitable proportion of grate surface and improved boiler room practice would result in a saving in the entire plant of from fifty to seventy-five dollars every day the plant is operated on the present average of steam consumption. This would, after making due allowance for the extra labor necessary to look after the extra number of fires or furnaces, and the lost time for "shut downs" for repairs, amount to not less than fifteen to twenty thousand dollars per year. This plant is by no means an exception. It is comparatively a new plant, and, in its mill or machinery equipment, and in general arrangement, the boiler plant so "modern" as to be considered a model by wideawake engineers and managers who contemplate new works or radical improvement of old ones.

## *Lessons in Practical Electricity*

### HOW TO DESIGN A DYNAMO.

In the preceding section the shunt coil was considered. The series coil now engages our attention. The coil must magnetize the field magnets sufficiently to overcome two factors tending to bear down the voltage, and must further raise the voltage at full load to 120 volts, an over-compounding of 10 volts, to compensate for line loss. The first of the factors tending to depress the voltage as the load comes on is the armature resistance, for additional volts are required to force the full load current through it. The other factor is armature reaction.

As to the first, we determined that the armature was to have 168 wires, that it was to be 6½ ins. in diameter and 11 ins. long. The wire was to be No. 8 B. & S. gage. It is evident that the total length of wire will comprise the following items:

168x11 ins. for the conductors.... 154. ft.
84x6.5 ins. for the back end connectors ..... 45.5 ft.

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| | |
|---|---|
| 42x6.5 ins. for the front end connections | 22.75 ft. |
| 84x2 ins. for commutation leads | 14. ft. |
| Fifteen per cent for the end connectors, to enable them to avoid the shaft and each other | 12. ft. |
| Total | 248.25 ft. |

Two hundred and forty-nine and one-fourth ft. of B. & S. No. 8 will have a resistance of .1565 ohms. We must remember, however, that this wire is divided in two halves which are connected in multiple, and their joint resistance is one-fourth of the above figure, or .0391 ohms. The full load current is 55 amps., and hence we

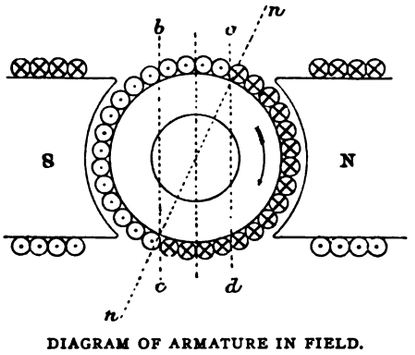



DIAGRAM OF ARMATURE IN FIELD.

need 2.15 volts to force this current through the armature.

The next factor, the armature reaction, can be determined only approximately, for before it can be computed a position must be estimated for the brushes. If we assume that the brushes are to be set opposite the pole tips, we shall have a margin which will not be too large.

Supposing the brushes to be set thus, it will be seen on examination that the slots between the pole pieces contain current-carrying wires, the magnetizing energy of which is directly opposed to the flux in the magnetic current. In other words, they are demagnetizing turns, and must be compensated for by additional turns on the series field. This will be better understood by reference to the accompanying illustration, in which is shown an armature between pole pieces. N N is the true line of the brushes, and the conductors from B to A and C to D constitute demagnetizing loops surrounding the magnetic circuit.

In the machine that we have designed there are seven slots between pole pieces. The polar gap is a little large, and as the field is quite strong, we will assume that the brushes are set only three slots away from the theoretical neutral line, making six demagnetizing slots. Each slot contains four loops, making twenty-four loops in all, and as each carries half the main current, we must wind half as many turns on the series coil to compensate for this factor.

We have a total of 12.15 volts to be generated by the series coil, and to the coil computed from this figure we must add twelve more turns for the armature reaction.

To generate 12.15 volts in an armature of 168 conductors revolving at 1500 r.p.m. there will be needed

$$N = \frac{E \times 100{,}000{,}000}{N\ C} = \frac{12.15 \times 100{,}000{,}000}{168 \times 25} = 289{,}000 \text{ lines.}$$

The flux due to the shunt field is 2,619,-046, and this, added to the series lines, makes a total useful flux of 2,908,046 lines and a field flux of 60 per cent more, or 4,652,,924 lines. The permeability at these fluxes must be determined, because it is at this magnetization that the 289,000 lines are forced through the magnetic circuit.

The calculation will evolve the following results:

| | |
|---|---|
| Density in field magnet | 84,600 |
| Permeability of field magnet | 1,200 |
| Density in armature teeth | 90,400 |
| Permeability of armature teeth | 860 |
| Density in armature body | 73,250 |
| Permeability of armature body | 1,550 |

We will also find it convenient to collect the following data for reference:

| | |
|---|---|
| Length of path in armature | 6.75 ins. |
| Area of path in armature | 39.70 ins. |
| Length of path in teeth | 1.39 ins. |
| Area of path in teeth | 32.19 ins. |
| Length of path in field magnet | 28.06 ins |
| Area of path in field magnet | 55. ins. |
| Length of path in air gap | .1 ins. |
| Area of path in air gap | 58.15 ins. |

From the foregoing we calculate the following:

Ampere turns necessary to force 462,400 lines through the field magnet at full load

$$\frac{462{,}400 \times 28.06 \times .3132}{55 \times 1200} = 61.6$$

Ampere turns necessary to force 289,000 lines through the gap space

$$\frac{289.000 \times .3132 \times .1}{58.15} = 155.5$$

Ampere turns necessary to force 289,000 lines through the teeth

$$\frac{289{,}000 \times 1.39 \times .3132}{32.19 \times 860} = 4.5$$

Ampere turns necessary to force 289,000 lines through the armature body

$$\frac{289{,}000 \times 6.75 \times .3132}{39.70 \times 1550} = 9.9$$

Total ampere turns ..... 231.4

The full load current is, as we know, 55 amps., and hence the turns necessary will be 4.2. To this we must add twelve turns to compensate for armature reaction, giving a total of sixteen turns. It will probably be found wise to use twenty turns, winding ten turns on each magnet limb. If this is found to be too much its magnetizing effect can be reduced by shunting; that is, by connecting a resistance across the terminals of the series coil. Most manufacturers are in the habit of placing several extra turns on their series coils and shunting, because one machine in this way can be made to answer for any given over-compounding percentage by simply varying the shunt.

It is also well to note that the shunt coil was calculated at an estimated total flux. Referring to the sections of this series published in the November and December numbers, it will be remembered that the shunt bobbin was to generate 2,619,046 useful lines. We determined the permeability of the basis of a maximum number of lines 4,950,000, which was estimated and not calculated. Having determined the additional flux the series coil must supply, we find the maximum flux to be 4,652,924 lines, and the total useful flux 2,908,046 lines.

The permeability as determined from these figures will be more accurate than those determined from the approximate figures, and might even change the size of the shunt wire a gage number. It would therefore be well to recalculate the shunt coil and see if the discrepancy is serious. At most it would only change the shunt wire from No. 22 Birmingham gage to the next size smaller. The size of the series wire should be determined on the basis of 1000 amps. to the sq. in. It is to carry 55 amps., and hence its area should be .055 sq. ins., which corresponds most closely to No. 2 Brown & Sharp gage. There will be a drop in these series coils which must be taken care of. This might be computed, but is best corrected by varying the shunt.

In calculating the series coil it will be seen at once that armature reaction plays a more important part than any other consideration, and as this can only be estimated approximately, it will not be well to follow the calculations too closely, for it is safer to leave a margin. In practice, series coils are determined by exciting the field magnets independently by what is known as an experimental coil, in which the number of turns are known. The current is measured both at no load and full load, and from this data the additional number of ampere turns which comprises the series coil can be readily determined.

## Letters on Practical Subjects

### An Electrical Paradox.

Of a number of letters on the above subject received after the December issue went to press, we select the following as giving the most general solution offered to the so-called paradox of Mr. Blake, printed in the November number:

*To the Editor of American Electrician:*

In your November issue I notice a letter, entitled "An Electrical Paradox," from Mr. C. D. Blake.

This problem may easily be solved by application of Kirchoff's laws, namely: The sum of all the e.m.fs. in a closed circuit is equal to zero, if the e.m.f. consumed by the resistance is also considered as a counter e.m.f., and all e.m.fs. are taken in their proper direction. The sum of all the currents flowing toward a distributing point is zero.

Let us take the general case represented by the following diagram, in which E and

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e; R, r and r'; and I, i and i', are the e.m.fs., resistances and currents respectively in the three paths connecting the points A and B.

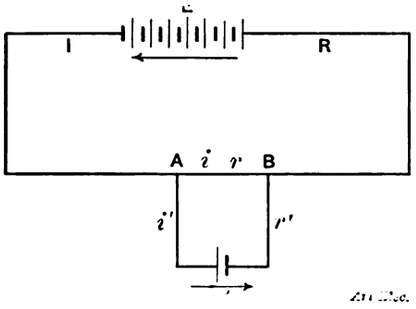



DIAGRAM OF CIRCUIT.

The directions of E and e are shown by the arrows. Then by the first law we have $E - I R - r i = o$ and $E - i R - r' i' + e = o$. And by the second law, $I - i - i' = o$.

Solving for I, i and i' we have

$$I = \frac{Er' + Er + er}{rr' + Rr' + Rr}$$

$$i = \frac{Er' + eR}{rr' + Rr' + Rr}$$

$$i' = \frac{Er + er + eR}{rr' + Rr' + Rr}$$

The condition that $i = o$ is that $Er' = eR$. That is, if $E : R :: e : r'$, there will be no current in the short wire A B. Also, if

$$\frac{E}{R} = \frac{e}{r}, \quad I = \frac{E}{R} = \frac{e}{r} = i'.$$

Mr. Blake will notice that it was necessary to make no assumptions in regard to the directions of the currents, but that they are evident from the equations. The secret of Mr. Blake's error is in the words: "If we apply an e.m.f. of 1½ volts to these terminals, opposed in direction to the direction of the current."

GEO. H. GIBSON.

Ann Arbor, Mich.

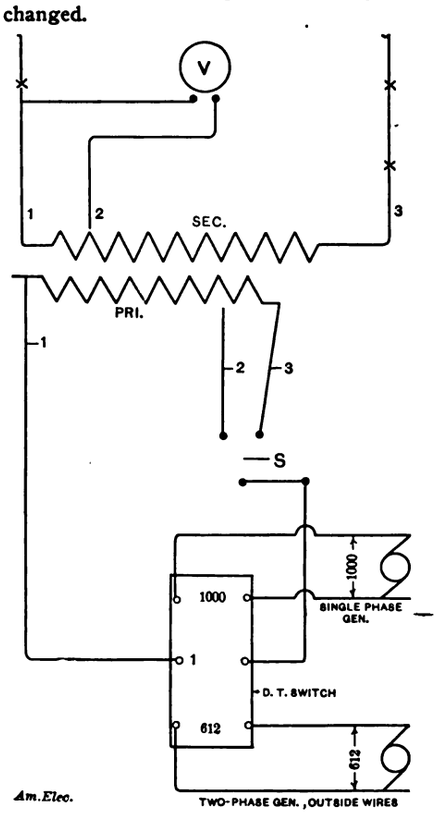
## Transformers For Series Lighting.

*To the Editor of American Electrician:*

Sir—The kind of transformer shown in the accompanying diagram does away with two or more separate circuits, as in the usual constant-potential service, which in a great many cases is a saving through reducing complication and trouble to a minimum, and avoiding having to run part of the lights on separate transformers. I am operating street lights on this plan from a 350-volt and 700-volt two-phase machine till midnight; then, by the use of a double-throw switch and a terminal-change switch, I connect to a 1000-volt alternator, which alternator is loaded till this time, and then shut the two-phase motor circuit down until the usual starting-up time in the morning.

As will be seen in the diagram, one end of the primary winding goes directly to the middle binding-post of a double-throw switch, marked 1; terminal two goes to a two-phase machine, and has a ratio of 2.45 to 1, the voltage of the two outside wires being 612 volts primary, and 1500 secondary.

The ratio of this full primary winding to the secondary is 1.5 to 1, which corresponds to terminal three, and by changing switch S, from two to three, and changing the double-throw switch to the binding-posts leading to the 1000-volt machine, the street lights are placed on the high-tension machine and the voltage of secondary not changed.




SPECIAL TRANSFORMER FOR SERIES LIGHTING.

Terminals one and two on the secondary of one, two and three, are for a voltmeter connection, which throws the voltmeter in shunt to the current passing through the winding, and the loop can be thrown out for any voltage desired.

Another plan for indicating the condition of street lights is to have, for incandescent lighting, a lamp wired on the switchboard in shunt to a switch but in series with the street lights, or an ammeter in case of arc lighting.

I have been operating street lights on this plan for about a year, and find it perfectly satisfactory. V. E. HUNTER.

Auburn, N. Y.

## Constant Speed Regulation.

*To the Editor of American Electrician:*

Having read in a recent number of the AMERICAN ELECTRICIAN an article concerning the regulation of the voltage of dynamos under sudden variations of load, I have tried to solve the problem, and send to you the result of my effort. The device is based upon the principle that the voltage of a dynamo responds almost instantly to every variation of speed.

It consists of a pulley so arranged that if when carrying a normal load, the load be suddenly increased, the increased tension of the belt will cause the circumference of the pulley to be promptly decreased, which will result in a prompt increase of the speed of the armature, thereby maintaining the proper voltage. Under such conditions the dynamo must be driven by a heavy link belt, as the conditions it will have to meet will be severe. The engine should be powerful enough to carry, and its automatic regulating device should enable it to meet, the increased load at a constant speed.

Fig. 1 gives an end view of the pulley. A is the shaft upon which are keyed the two hub rims, B. Between the hub rims, and turning easily upon the shaft, is the regulating gear, C, upon the teeth of which work the regulating arms, D, which support the segments of the pulley rim.

FIG. 1.

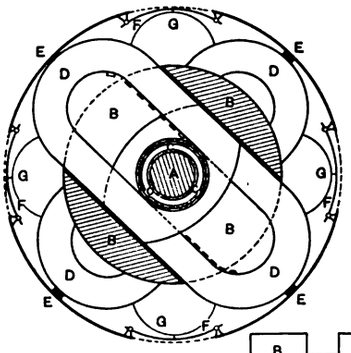
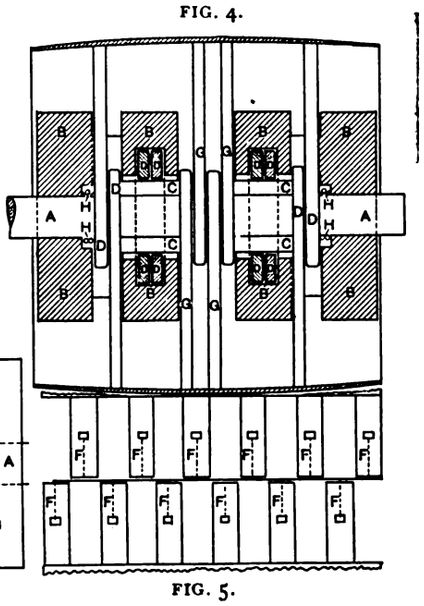



FIG. 4.



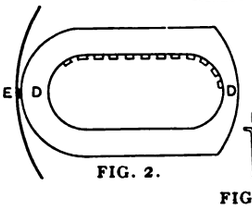




FIG. 2.

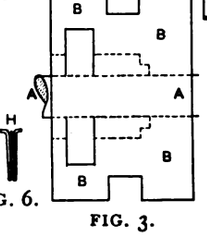



FIG. 6.

FIG. 3.




FIG. 5.

FIGS. 1 TO 6.—DETAILS OF PULLEY.

The ends of these segments are slotted as shown in Fig. 5, and are kept at their proper curvature by the devices, F, which

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are controlled by the secondary pair of regulating arms, G, which work upon and are controlled by the regulating gear, C. This regulating gear is fastened at each end into the hub rims, B, by two coil springs, H. Under normal load they will be set to hold the pulley at its greatest tension. An accurate test of the springs can be made by varying the tension of the belt, until at normal load the springs just begin to yield.

In this condition the slightest increase of load would increase the tension of the belt, forcing the arms D together, rotating the gear C against the springs H, and decrease the diameter of the pulley, which would increase the speed to meet the conditions and keep the voltage where it ought to be. A decrease of load would result in the springs restoring the pulley to its normal state.

AVA R. COLEMAN.

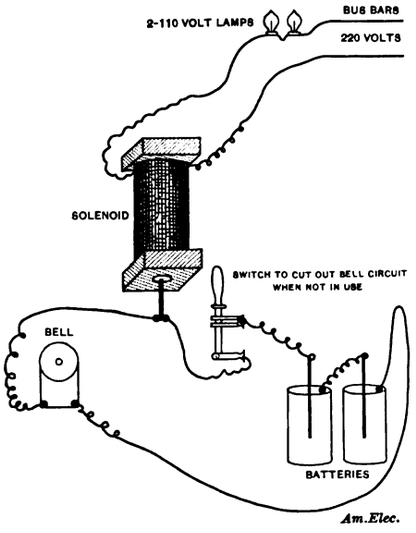
Portland Head, Me.

## Broken Circuit Indicator.

*To the Editor of American Electrician:*

The accompanying sketch represents a very simple arrangement for indicating when a circuit-breaker is thrown, or when a fuse blows. I have the solenoid mounted on a switchboard and connected to the bus-bars with two 110-volt lamps in series, as shown.

With current flowing around the solenoid,




BROKEN CIRCUIT INDICATOR.

the plunger, A, is held up, but if the circuit is opened in any way it drops down and comes in contact with the points, BB, and rings the bell.

G. W. HARROLD.

Philadelphia, Pa.

## Boiler Feeding Apparatus.

*To the Editor of American Electrician:*

Sir—In a recent issue, Mr. Jas. F. Hobart calls for a discussion of boiler-feeding mechanisms. He enumerates, and to some extent comments upon, five—exhaust injectors, live-steam injectors, return traps, steam-driven pumps and belt-driven pumps.

The exhaust injector, up to 70 lbs. working pressure, is a satisfactory and ideally economical apparatus. Above 70 lbs. it cannot be relied on. Below this, its only fault is a little trickiness about starting, especially in water carrying scale-forming material. Its low working pressure, however, puts it out of the question for any modern plant.

The live-steam injector consumes more steam to do its work than any other boiler-feed mechanism. In relation to this and to the return trap, Mr. Hobart says that practically all the heat in the steam used is returned to the boiler. This is, in one sense, true, but it is also true that if the plant is otherwise properly designed this heat is entirely wasted. A proper equipment of exhaust steam heaters will raise feed water from 60° to 200° F. before entering the boiler. This means that 140 heat units per pound of water are supplied to the boiler from a source exterior to itself and the fire. Now, with the injector and return trap the heat units in the steam consumed are absorbed by the water, and so returned to the boiler, the water being heated in passing through the apparatus. But if this water is sent through the same set of heaters as before, its temperature on reaching the boiler will be no higher than if it had entered the heaters at 60°. Since the feed water entering the boiler is no hotter by reason of the steam used in the injector, the boiler is the loser by the whole of this steam.

The return trap is nothing more or less than a steam pump, reduced to its simplest form. It employs directly for putting the water into the boiler, a volume of steam equal to that of the water. As compared to the steam pump, it removes the waste due to clearance, and piston and valve leakage on both ends; it introduces waste due to the contact of the steam and water. It cannot be true that the consumption of steam is as little as twice the volume of water.

After the trap is discharged, the external radiation must, with 150 lbs. working pressure and 15 lbs. pressure in the water main, condense 4/5 volume of steam before any water can enter. This same rate of radiation is maintained while the trap is filling and emptying. Also, while emptying, the steam at full boiler pressure is in contact with the water, and condensation from this cause must be rapid.

Were data at hand showing the rise in temperature of the water while passing the trap, the steam consumption could be immediately determined. Such data I have been unable to procure. I am, however, informed by the sellers of one make of these traps that with hot water and 70 lbs. boiler pressure the rise of temperature is about 15° F. This would indicate a consumption under these conditions of about five volumes of steam for each volume of water. This consumption will certainly not decrease with rise of pressure, and at 150 lbs. would make 1.8 lbs. of steam per cubic foot of water fed, or about 165 lbs. of steam per horse-power hour.

The steam-driven duplex pump has in its favor convenience, readiness of adjustment to varying load, and ability to stand abuse without absolute breakdown. Its drawbacks are, lack of economy and continual attention required to keep it up to maximum efficiency. The lack of economy is, of course, well recognized, but hardly goes as far as Mr. Hobart asserts. Of course, "coal" was printed by mistake for "water," but the pumps that consume from 250 to 400 lbs. of water per horse-power hour need, I should think, to have the repairs begin at the man in charge of the boiler room.

The belt-driven pump, for steady loads, undoubtedly stands at the head. Under any ordinary circumstances it should consume not more than 60 lbs. of water per horse-power hour. For variable loads it is troublesome or comparatively wasteful, according to the way it is regulated. It can be used only while the engine is running, and therefore must be an additional machine, not to be reckoned on as a relay.

The different mechanisms seem to rate as follows, in order of economy: Exhaust injector, belt pump, return trap, steam pump, and steam injector.

I think the reason why the two most wasteful of these are in most general use is, that either can be used whenever steam is up; either, if no attention be paid to economy, will keep running with very little attention, and the steam pump can be regulated in a moment to discharge any desired amount of water. It is simply another case where, in the mind of the man who has to take the trouble, simplicity and convenience outweigh economy.

JOHN WILSON BROWN, JR.

Philadelphia, Pa.

*To the Editor of American Electrician:*

Sir—The letter of Mr. Brown is to the point. I wish to ask Mr. Brown, however, if he has ever tested injectors by forcing a given quantity of water from one vessel to another, weighing the liquid accurately before and after, and noting the temperature in both tanks, the requisite pressure being gained by forcing through a safety valve in the delivery pipe, to maintain the head to be worked against?

After weighing and taking temperature, the "lost units," *i. e.*, those not accounted for by the increase of temperature of the water, will denote the actual work done in forcing the given quantity of water, while the increase in weight shows exactly the amount of steam condensed. It is a pretty experiment, and opens one's eyes considerably to the great cost of feeding boilers by the injector.

Regarding the cost—400 lbs. of water per horse-power hour—I quote the published catalogue of a well-known pump-making concern. The wastefulness of duplex pumps is stated from another and similar publication, coupled with my own observation.

It would, however, be cheaper for a concern to buy power from the nearest electric company, and run a special pump and motor for feeding boilers, than to use either a duplex pump or an injector. This would effectually lay that bugaboo always

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brought up against the belt-driven pump, viz.: "That it can only work when the engine is running."

A large lighting company in Brooklyn recently put in electrically driven pumps for all purposes throughout their new station—feeding boilers, air circulating pumps, and for washing out, etc. They are so connected that should the entire station be shut down, storage batteries would drive the pumps during the limited time of idleness.

JAMES F. HOBART.

Brooklyn, N. Y.

## Electrical Catechism

*256. What is the principle of the "magnetic vane" instruments?*

The magnetic vane instruments have two soft iron cores, one of which is fixed and repels the other one, which is pivoted and free to move. The two iron pieces repel each other, since they are magnetized in the same direction; also since the repelling force is greatest when the two are closest together, the force moving the needle or pointer is considerable even with small currents, and the instrument may be calibrated from a point near the zero of the scale.

*257. Is an instrument liable to injury if not connected properly into the circuit?*

Usually instruments are not injured if the polarity is reversed so that the current flows in the wrong direction. If the instrument is intended for alternating currents, of course its readings are independent of the direction of the current. If the instrument depends upon the action of a permanent magnet, the pointer simply moves in the wrong direction and goes against a stop.

*258. How can one be sure that the current will not be too much for the instrument?*

In the first place he must exercise some judgment, as a knowledge of what load is on the circuit will ordinarily enable one to estimate the probable current or voltage to be expected. He must be careful that he does not try to use an ammeter for a voltmeter or a voltmeter for an ammeter, unless he knows exactly what he is doing. If the voltmeter has two scales, he should first try the circuit with the instrument connected for use with the higher scale to learn if he can safely use the lower scale.

*259. When a voltmeter has two scales, how can one tell which terminals to use to get the right scale?*

Voltmeters with two scales usually have three terminals, one on one side of the instrument and two on the other side. The single terminal is used for both scales. One of the two terminals on the other side is usually smaller than the other, and one can easily remember that the smaller terminal goes with the smaller scale.

*260. How can one tell whether an instrument is an ammeter or a voltmeter?*

Almost all instruments are marked. If the scale is marked to read amperes, or if the name on the plate states that the instrument is an ammeter, an amperemeter or a current indicator, one may be sure it is intended for measuring current and not volts. So, if the scale is marked to read volts, or if the name plate states that it is a voltmeter, pressure indicator or potential indicator, it is for measuring voltage and not current. If the instrument has no marks of identification, the size of the terminals or binding posts will be an indication, ammeters usually having comparatively large terminals, while voltmeters have small ones. One can generally get some idea of the size of the conductors in the coil either by looking through the glass front or by taking off the cover. If the wire is about the size of a coarse thread or smaller, the instrument is a voltmeter or a milli-amperemeter. If the wire is larger, the instrument is an ammeter. If the instrument has two large and two small terminals, it is a wattmeter, or possibly a combined ammeter and voltmeter.

*261. What would be the effect of sending too much current through an instrument?*

The pointer would be thrown violently against the upper stop, with so much force that it would probably become permanently bent. If the excessive current is allowed to continue through the instrument for any length of time, it is likely to heat the wire to a dangerous temperature and destroy the insulation or perhaps melt the wires. The same effects are also produced if a voltmeter is connected across a circuit of too high voltage, since that would send too much current through the coils. In the case of a static voltmeter in which no current flows, too high voltage is liable to jump across and short-circuit the instrument and the line.

*262. Is it better to close the circuit at an ammeter or at some other point in the circuit?*

The circuit should not be made or broken at the ammeter terminals, since it is not easy to close the circuit without making an uncertain contact, which causes arcing and burning the terminal. Also, it is not possible to open a circuit at the ammeter without drawing an arc which burns and disfigures the terminal. It is a good plan to have the ammeter near a switch, that one may see what current flows at the instant the circuit is closed, so that if anything is wrong he can open the circuit before considerable damage is done.

*263. Is the reliability of an instrument affected if the terminals are burned and blistered?*

The instrument itself might not be injured at the time, but a disfigured instrument is almost sure to be looked upon as being an old one and unreliable, hence it is more liable to abuse. The man using a disfigured instrument is also sure to think that, as the instrument is a poor one, it makes little difference whether he does accurate work, since he cannot depend upon the instrument anyhow. Thus the practice of using the ammeter as a switch for closing and opening the circuit is very apt to lead to poor work from those thus using it.

*264. In what way is an instrument liable to be abused?*

By careless use as a switch, by rough handling, and by its use with excessive currents or voltages.

*265. How does rough handling injure an instrument?*

The best voltmeters and ammeters are made much like a watch, with small pivots which rotate on jewel bearings. Rough handling is apt to crack the jewels or to dull the ends of the pivots, or to spring the parts. Rough handling is also liable to weaken the permanent magnet, if the instrument has one, which will make the instrument read too low or too high.

*266. What kind of instruments read too high if the permanent magnet is weakened?*

Instruments such as those formerly made by the T.-H. Company, in which the pointer is attached to an armature of soft iron that is held toward the zero point by a stationary permanent magnet and is deflected by a coil, whose magnetizing effect is at right angles to that of the magnet. When the magnet becomes weak, the relative pull of a given current through the coil becomes greater, and the pointer is then deflected too far, thus making the instrument read too high.

*267. What kind of instruments read too low if the permanent magnet is weakened?*

Instruments such as the Weston or Whitney, in which the coil rotates in the field of the permanent magnet. In such instruments the pull of the coil is opposed by a pair of springs. The pull of the coil is proportional to the product of the strength of the magnet and the ampere-turns in the coil. If then the magnet becomes weaker, the pull between the coil and the magnet becomes weaker for a given current, and since the strength of the opposing springs has not been affected, the instrument reads too low.

*268. Is an instrument liable to give incorrect readings even if it is in good order?*

Yes, to some extent. Most instruments are more or less affected by outside magnetic influences. Many instruments give correct readings only when approximately level or when vertical, according to the style of instrument.

*269. How does leveling affect instruments?*

Some instruments, such as the Siemens electro-dynamometer (see No. 224, "American Electrician," July, 1898, page 345) must be carefully leveled so that the moving coil shall hang exactly in the same position with reference to the stationary coil, for the magnetic field of each coil varies in different positions, as it is necessary for the two to occupy exactly the same relative positions as when the instrument was calibrated. In many instruments of a more portable form the moving parts are balanced for only one position, either for horizontal or for vertical use. If the instrument is placed in any other position, the pointer is liable to stop at some other place than at the zero point, and being wrong at the starting point, every other indication of the pointer is liable to be incorrect.

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# Queries and Answers

**How many dry cells will be required to heat 1½ ins. of No. 32 platinum wire to a white heat for an instant?** C. E. F.

Try one dry cell, or two or more in parallel.

**Why is a booster connected in the positive lead of a dynamo charging a storage battery?** P. M.

It is entirely immaterial in which lead a booster is connected.

**I am desirous of constructing a Wheatstone bridge of the dial or Elliot pattern, but using switch levers instead of plugs. Would such a bridge be reliable?** H. H.

No, on account of contact resistance, which would not be constant with levers.

**What is the voltage and life of a Clark cell?** H. N. K.

1.435 volts. If properly used, and no appreciable current is drawn, the cell should last for years.

**What will be the effect on a transformer built to operate under 16,000 alternations per minute, if used on a circuit of 7200 alternations?** J. R. C.

It will overheat, owing to the larger current in primary, due to the reduced choking effect.

**How is the discharging current of a storage cell determined?** R. C.

Obtain the area of both sides of the positive plates, and allow from 8 to 9 amps. per square foot.

**Is there a mechanism for attachment to a dynamo in order to get its characteristic curve?** R. B. W.

No. All that is necessary for this purpose are simultaneous readings of a volt and an ampere meter.

**If I put rings on a direct-current motor, start it up with direct current and then switch on alternating current, will it continue to run?** J. J.

No, unless the direct-current speed is the speed of synchronism—that is, the alternations divided by the number of motor poles.

**What should be the resistance of the primary and secondary of an induction coil, to be used in lighting 3-c.p. lamps from constant current cells?** J. E. P.

As the loss in such an induction coil will be great, and as the voltage of such lamps is low, it will be far cheaper to buy more cells, and work direct from the battery.

**Are buildings more apt to be struck by lightning if telephone and telegraph wires are attached thereto?** J. J. P.

Theoretically an argument can be advanced either way. Practically, we have never seen any case recorded where a building having such wires was struck by lightning.

**I have a choke coil which "chokes" harder with the core out than when it is in. What is the reason?** C. A. K.

The fact mentioned is very peculiar, and might be due, if the core is solid and of large section, to eddy currents setting up lines that largely neutralize those tending to act on the coils.

**How much current from a 110-volt circuit will be required to heat a fair-sized room in ordinary winter weather?** L. A. V.

Anywhere from 10 to 40 amps. The test may be made with a bank of incandescent lamps as a heater, since 97 per cent, or practically all, the current supplied to such lamps is transformed into heat.

**Will a Shallenberger ampere-meter register correctly in a 2400-volt primary circuit?** H. C. P.

Yes, but if the circuit contains transformers the product of the volts and amperes will be the apparent, and not true, watts; to obtain the latter, multiply by the power factor or cosine of the angle lag, which must be determined.

**What are front and back pitch in armature winding?** W. W. B.

The front pitch is the angular distance, expressed in coils or slots, between the starting end of a given coil and the returning end of the connected coil; the back pitch is the angular distance, in similar units, between the two sides of a given coil.

**How much secondary and primary wire, and what diameter and length of core, will be required by one-inch induction coil for a 100-volt circuit?** C. M. H.

Two pounds of No. 36 wire for the secondary, and for the primary a single turn of No. 18 wi e, wound on a ¾-in. core 9 ins. long. Adjust the current by placing in series with the primary two or more lamps in parallel; the limit of current will be indicated by the heating of the primary.

**What size battery would be required for 16 16-c.p. house lights?** J. J. M.

Assuming that half of the lamps are burned on an average of two hours per night, the consumption is, for 55-watt lamps, 880 watt-hours. At fifty volts, this will correspond to 17.6 amp.-hours, or 70.4 a.-h. in four days; therefore, twenty-five 70-amp. hour cells will be needed if recharged every four days.

**1. How much current is consumed by a 16, 32 or 50-c.p. lamp on a 100-volt corcuit. 2. How much current is used by a series of twenty 32-c.p. 50-volt lamps in a 1000-volt circuit?** J. O.

1. The current is found by dividing the watt rating by the voltage. If the rating of a 16-c.p., 100-volt lamp is 50 watts, it takes ½ ampere; a 32 and 50-c.p. lamp of the same efficiency will take 1 ampere and 1.56 amperes, respectively. 2. Precisely the same as one of the lamps when connected in parallel.

**What advantage, if any, has a frequency of 60 over that of 133 for operating arc or incandescent lamps and motors?**

The higher the frequency, the higher the inductive line drop. Arc lamps can be constructed to burn equally well at both frequencies. High frequency are cheaper than low-frequency transformers. Low frequencies are most suitable for motors, on account of lower speed involved, and less so-called idle line current.

**How is aluminum tempered?** A. R.

Aluminum cannot be sensibly increased in hardness by the addition of any substance in small quantity. Casting will give it a hard surface, as will also rolling, but in no case has it been made harder throughout than very soft brass. A method of hardening aluminum without greatly increasing its specific gravity would prove a profitable invention.

**What is the resistance of a plate of mica 1-64 in. thick and 1 sq. ft. in area?** G. T. H.

Assuming the resistivity of mica (the resistance of 1 square centimeter 1 centimeter thick) to be 84 meg-megohms, the resistance of the plate named will be less in the ratio of 1 sq. ft. to 1 sq. cm., and of 1 cm. to 1/64 in., or 22,300; dividing by this gives 3767 megohms. It is the disruptive or dielectric, strength of mica that applies when used commercially; it is practically a non-conductor, as will be recognized from the figure calculated.

**How can I test the setting of the valves of an automatic engine without using an indicator?** L. A. S.

Place a pencil somewhere on the governor mechanism, and when the engine is running with the desired load, hold against this pencil a board, clamped securely to some solid foundation. The pencil will describe a mark upon the board. The engine should then be shut down, and the governor blocked out until the pencil reaches this mark once more. The cover of the valve chest may then be taken off, the engine turned over by hand, and the relative positions of the various events of the stroke determined.

**How can the rotary field be simply illustrated?** A. V. D. N.

Against two opposite sides of a square glass jar place zinc plates; fill the jar with blue vitriol solution, in which rotate three zinc rods, secured to a disk at equal intervals from each other; on the axis of the disk have three collector rings, to which connect the rods. If the zinc plates are put in circuit with a battery, and the disk revolved, three-phase currents may be taken from the rings. If these currents are led to three equidistant points of a closed winding on an annular ring, a rotary magnetic field may be obtained of a frequency corresponding to the rate of rotation of the disk.

**What is the e.m.f. of a nickel-iron couple?** G. T. L.

Between the temperatures of 480 and 590 degs. Fahr. the thermo-electric power of nickel is much higher than at lower or higher temperatures. The e.m.f. of a nickel-iron couple within this range is about .1 millivolt. At a low temperature the couple is .03 millivolt, or there is available .07 millivolt per degree Fahr. Assuming the range to be between 550 and 50 degs., a nickel-iron couple will give .035 volt, or one hundred couples will give under the conditions named 3.5 volts, being thus almost equal to a bismuth-antimony couple.

**What are the comparative insulating properties of glass, mica, gutta-percha, shellac, ebonite and paraffine?** G. T. H.

The resistivity of insulators varies greatly with temperature, duration of electrification, purity and physical state, and the condition of surface also greatly affects their insulating property. Glass, for example, has a resistivity over 70,000 times greater at 2 degs. F. than at 145 degs. F., and different experimenters give figures for the resistivity of glass, which vary from .7 meg-megohms for common glass at 140 degs. F., to 10,200 meg-megohms for flint glass at 140 degs. F. The following comparative numbers (from Everett) are therefore only approximate: Flint glass, 102; mica, 8.4; gutta-percha, 45; shellac, 900; ebonite, 2800; paraffine, 3400.

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## STORAGE BATTERY, AUXILIARY AND OTHER IMPROVEMENTS IN THE CENTRAL STATION OF THE WILMINGTON CITY ELECTRIC LIGHT COMPANY, WILMINGTON, DEL.

The Wilmington (Del.) Electric Light Company has recently installed some interesting additions to its plant, of which a traveling staff correspondent sends the description which follows:

### STORAGE BATTERY.

In connection with its power plant, a storage battery has been installed of a size sufficient to carry half of the load of the station. The battery is of the Willard type, made by Sipe & Sigler, of Cleveland, O., and consists of 144 cells, each 22 ins. x 40 ins. x 34½ ins. Each of these cells has an ultimate capacity of 3750 amp. hours, but at present contains but 19 plates each, making a capacity of 2000 amp. hours.

The containing tanks are made from hard wood 1¾ ins. in thickness, and are treated outside and inside to two coats of insulating compound, after which they are lined with four-pound lead. Each cell complete weighs something more than a ton. The 144 cells complete contain something more than 1000 carboys of electrolyte.

The elements at present consist of 19 plates each, each plate 15½ ins. x 24 ins. x ⅜ in. The positive and negative plates are made in the same manner. A sheet of pure rolled lead is used, from which thin leaves are raised at an angle so that a cross section of the plate has a herring-bone appearance. By this method of construction, each plate is given about 6000 sq. ins. of surface contact between the active material and the conducting support. The active material is created by an advanced electrochemical process. No paste is used and no mechanical application of active material in any manner.

The chief merit claimed for this construction of the plate is in its enormous surface, which enables it to absorb and give forth an enormous current at high efficiency. The shape of the leaves is such as to hold the active material in position, and to admit of the expansion due to the growth of active material without any liability to buckle, bend or distort the plate.

The plates are separated from each other by means of glass tubes suspended by hard rubber insulating supports, which rest upon plates of like polarity only, thus avoiding leakage. The cells are insulated from one another and from the ground by means of large and thoroughly vitified and triple-petticoat glazed porcelain insulators, and are connected in series by means of heavy lead bus bars, to which the terminals of the plates are lead-burned by means of an oxy-hydrogen flame.

The station has recently been enlarged by an L-shaped brick addition, a portion of which is divided into two stories. In the narrowest portion of the L the cells are arranged on each side, with an aisle between, and in the other portion there are four rows of cells. An interesting feature of the arrangement is that all the copper and switch connections are located on the second floor, immediately over a portion of the battery, and individual lead bars lead from the terminals of each cell up through this floor, where the connections are made, and into the same room, from the individual terminals of the other portion of the battery a heavy cable delivers the current, so that all the copper is entirely protected from any of the deleterious fumes escaping from the battery.

### TRANSFORMING A SINGLE INTO A COMPOUND ENGINE.

The station changes include the making over of the single high-speed engines into a compound engine, and coupling the two cylinders direct to a 175-kw. generator of the General Electric type. The cylinders of the original engines were 14 ins. x 13 ins. On one of the engines this is replaced by a low-pressure cylinder, 21 ins. x 13 ins., and the two are placed side by side and coupled, as before noted, to the armature shaft of the generator, an additional framework being placed between the pillow blocks, which helps to carry the weight of the shaft, which is thus given four bearings. The valve gear remains about as before, and the governing is done on the high pressure cylinder. This is not an experiment in this station, as a pair of engines were made over in this manner some years ago, and, having given good satisfaction, the other four engines are being thus compounded.

The output of this station is reinforced by current generated by water power at a woolen mill, two miles out of the city. This current is generated by a 50-kw. machine, and delivered to a double Stanley rotary transformer in the central station at 2500 volts, and is transformed on one side to an alternating current of 1200 volts for the Edison three-wire system and into a direct current of 115 volts. The transformer is operated by two old type Edison generators, placed on each side of the transformer, with the armature shafts coupled direct to that of the transformer.

### BOILER EQUIPMENT.

The original boiler equipment has been replaced by three vertical water tube boilers of the Moran-Climax type. Two of these are 350 h.p. each; the third, quite recently installed, is of 600 h.p. The superintendent of the station, Mr. C. R. Van Trump, reports a decided increase in orders for current, both for lighting and power, greater than that for a number of years past.

While making the rounds of the station a novel use for old oil barrels was noted. These were being used for shipping copper scrap. The old wire, after the insulation has been burned off, was coiled in bunches and then packed into the barrels by means of a heavy iron bar, which was used as a pounder, a very considerable quantity being thus packed in a barrel.

## THE MANUFACTURE OF TELEPHONES AND CALL MESSENGER BOXES.

### THE VIADUCT MANUFACTURING COMPANY.

For the benefit of the novice in telephone instruments it may be stated that the principal parts of an outfit consist of a call bell, or magneto bell, a transmitter, receiver, one or two cells of battery, and a containing case or cabinet, with the necessary connections and switches. For desk use the case is omitted, while the call bell may be located at a convenient place about the desk, and the battery at any convenient place. The instruments which it is the province of this article to describe are manufactured in great numbers by the Viaduct Manufacturing Company, of Baltimore.

The instruments are made in great varieties, as shown by the types illustrated in the accompanying illustrations. Some of the special characteristics are found in the construction of the magneto bells—really small generators—which are constructed with four permanent magnets made from steel bars, 1¾ x ¼ in., and bent in horseshoe shape, the limbs being about 5 ins. in length. These are arranged in pairs, one of each pair being placed astride the other, and the pairs placed side by side and connected by horizontal pole pieces between which the armature revolves. The armature is made with a cast core of soft iron, so shaped as to receive two coils of magnetizing wire. The commutator is placed on the end of the shaft outside the bearing, and is connected by a lead through the hollow shaft, while the other conductor is attached to the case. The gear wheels are toothed, four to one, so that in ordinary ringing the armature makes about 800 revolutions per minute. The bars employed for the horseshoe magnets are permanently magnetized after being bent by being drawn by hand four or five times across the core of a strong electromagnet, the terminals of which are grooved and adjustable, so that magnets of different sizes may be treated from the same pole. The electromagnet is energized by means of a current from a 50-volt generator.

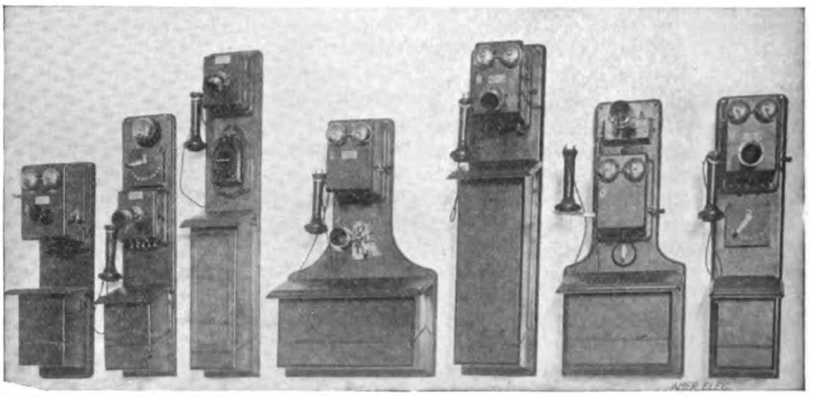
In the transmitters hard rubber insulation is employed in place of fibre formerly used, and coarser granules of carbon used in the chamber for receiving the diaphragm vibrations than formerly.

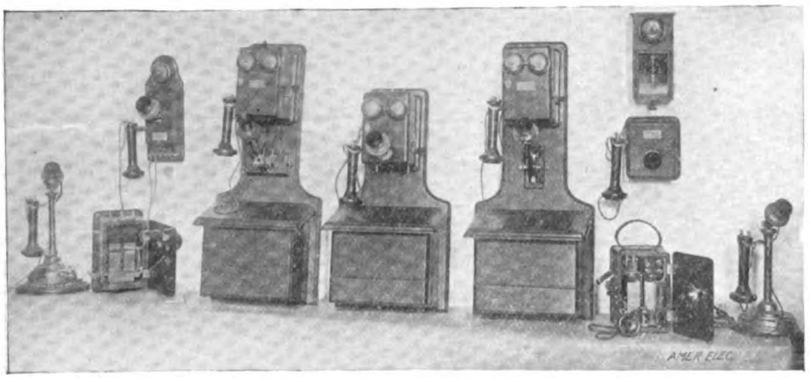
Among the new designs is a nickel-plated desk equipment in which the call bell is not cut out if the operator should fail to hang up the receiver. Another instrument is especially designed for use in warehouses, building exchanges, or in street railway offices, and which operate independent of any telephone exchange. These are made in two patterns, one a desk instrument, with a switch located in the base, the other a wall instrument, with a switch on the face of the case, by means of which calls can be made to the different rooms. In this instrument the calls may be received with the switch on any point, but in order to talk with the new call it is necessary to place the switch upon the home stud. The use of this instrument avoids the necessity of a switchboard and attend-

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ant. A good many instruments are now made with an arm rest on which the operator places the elbow when talking, and by means of which the contacts are made, so that the contact is sure to be broken even should the operator leave the box and fail to hang up the receiver.

A profitable outfit is also made designed for use by street car conductors or others who are required to report to the starter or station from any point on the road. For using this instrument when no provision has been made contact is made by throwing a wire over the line wire, and making a ground connection, but where metallic circuit is employed contact is made with both limbs of the service. For street railway circuits, however, it is usually attached, cut-outs providing at intervals on the trolley poles, to which the plugs of the instrument can be attached. This outfit consists of a generator ringer, a receiver of hard rubber, a transmitter, and two-cell dry battery; this is all enclosed in a case and provided with a strap for carrying, and the outfit weighs only about nine pounds.





FIFTEEN TYPES OF TELEPHONES.

The output of the Viaduct works is not by any means confined to telephones, but includes different types of district telegraph signal or call boxes, of which thirty-five different patterns are made, some known as "Answer Back" boxes, which give a return acknowledgment signal when a call is received.

The output of the works in call boxes is from 8000 to 10,000 a year, and the capacity of the works for making telephones in addition to the call boxes is about 200 per day, complete, including the bells, transmitters, receivers and the cases. In addition to the above named products from the works they supply telegraph relays, lightning arresters and switchboards for central stations, and as a specialty an instrument known as a police fire alarm and trolley signal outfit designed for use on trolley lines or in outlying districts. This instrument is enclosed in an iron shell or case, which can be readily attached to poles, and in connection with those in use on trolley lines is a large vibrating gong, which may be sounded by a starter to signal the conductor of a passing car should he wish to communicate with him while on his trip.

The works of the Viaduct Company are located near the Relay Station, on the Baltimore & Ohio Railroad, nine miles from Baltimore, and near the end of a high arch stone viaduct on which the tracks of the railroad cross the river, and from which the company takes its name. The tract owned by the company embraces twenty-five acres of meadow and wild land, and the works include twelve buildings, some of them being residences for the employees. The average number of hands employed is 125, and some of them, as above noted, have been in the company's employ for many years.

The machinery of the works is driven by water power, four vertical turbine wheels of the Leffel type being employed. The water is conducted to the wheels through a race which leads out from the river some distance above the viaduct. It has a fall of about seven feet, or sufficient for about 200 h.p. The power is transmitted to the machines of the different buildings by means of shafting and belts. The power building is 100 x 140 ft., a part of which is used as a storeroom for supplies, and includes the nickel-plating and burnishing department, while the generators for lighting and other current purposes are also in this building.

The principal machine shop is 208x40 ft., and provides for the iron and woodworking departments, as well as for the packing and shipping departments. There is a very full complement of iron working tools, consisting of lathes, screw machines, radial and gang drills and punches. Some of the tools are equipped with an electric device which automatically rings a bell when a piece of work is finished, so that one man is able to operate three or four machines. An exhaust system for removing the dust and shavings from the machines in the woodworking department is provided, and all through the works are minor labor-saving appliances and means to facilitate the handling of material. Oak, black walnut and mahogany are chiefly used for cases, and a drying kiln is provided in which all the material is thoroughly seasoned before being cut up for use. The varnishing department occupies a building 60 x 48 ft., where the polishing and hinging is done by hand work chiefly.

The main office and storeroom are located on Howard Street, in Baltimore, and here the president and manager, Mr. A. G. Davis, can usually be found. Mr. Davis has had long experience in electric lines, having learned telegraphy in 1849 under the instruction of his cousin, Samuel F. B. Morse, the pioneer in message transmission. In his career he has had charge of the construction of a number of telegraph lines, including the original equipment of the Grand Trunk Railway in Canada.

## CAHALL WATER TUBE BOILER FACTORY.

Steam users are quite familiar with the phrase "Cahall's sales department," but for the uninitiated it is explained that this is a department located at Pittsburgh, Pa., for the control and sale of the Cahall water tube boilers, which are manufactured by Aultman & Taylor, Mansfield, Ohio.

On a recent visit to the works at Mansfield, the writer was agreeably surprised to find that they were among the largest and best equipped boiler works to be found in the country. The output consists of horizontal and vertical boilers, the former in general appearance being like the type of boilers turned out by other well-known makers of water-tube boilers. The main building is of brick, with high walls and high monitor roof, and the tool equipment in every department is of a high order, including almost every labor-saving device to be found in works of this character. Large electric traveling cranes serve to shift and handle the largest boilers, while many of the larger tools are operated by independent electric motors.

Among the special tools were noted a plate planer 22 ft. in length, a hydraulic flanging press, pneumatic riveters and reamers, drills and chipping tools. Special

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attention is given to the material used, the flue headers being made of cast-flowed steel. The testing department, in which every bank of flues is tested for leakage and strength, is very complete, and provided with trolley hoists, by means of which the groups of flues are readily handled and adjusted. The capacity of the works is almost unlimited, turning out the largest orders in from six weeks to two months.

The works have supplied one of the largest iron mills in Pittsburgh with boilers aggregating more than 30,000 h.p. The company also makes a specialty of designing and manufacturing boilers for street railway and electric lighting plants. Being within easy reach of coal and near the boiler-plate manufacturers, and with a reasonable market of skilled labor to draw on, the works are fortunate in their location, while their equipment, as has been noted, is such as to turn out work of the highest character in the most economical manner.

## AN ARC LAMP FACTORY TESTING ROOM

A casual glance at an arc lamp would give but a faint idea as to the amount and variety of work expended in its construction, or the extent of the plant required for its manufacture on a large scale. Neither is it well recognized that such a lamp embodies mechanism which, though simple, is required to keep the carbons in an adjustment that is micrometrical in order and most delicate in kind. Moreover, as a lamp when it leaves the factory must be ready to satisfy this requirement under the most adverse conditions, it will be seen that the testing department of an arc lamp factory is one of extreme importance.

Lack of space forbids giving in this number a description of the manufacturing plant of such a factory, and attention will, therefore be confined to the testing department. As a text, the factory, at Peabody, Mass., of the Standard Thermometer and Electric Company will be taken, which, notwithstanding the non-committal of the firm name in that respect, is one of the largest makers of arc lamps in the world. An idea of the extent of this plant may be gained when it is stated that the main building occupied is 50 x 60 ft. in ground area, and four stories and a basement in height. In addition, there is a two-story 20 ft. x 50 ft. annex.

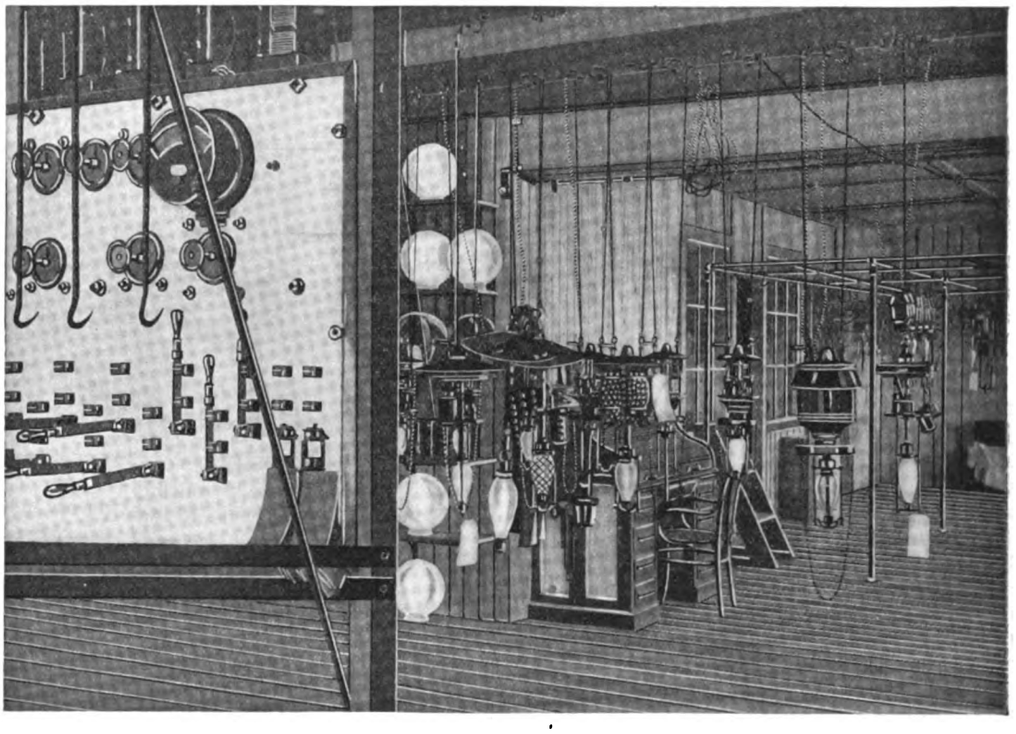
The arc lamp testing room, part of which is shown in the accompanying cut, is on the third floor. There are three separate switchboards in this room, one for alternating current, equipped with racks for testing open A.C. lamps, and with instruments for controlling the alternating dynamo in the basement. The second board, a corner of which is shown in the cut, carries the controllers for the multi-polar direct-current dynamo in the basement, used for lighting the shop and for testing the 110-volt lamps, either open or inclosed. For testing inclosed arc lamps there are ranges of drops, into which the lamps can be connected, and to which current can be run from either the A.C. board or the D.C. board, at will. This diversion of current, as well as the handling of the high-tension currents, is done by means of the third switchboard. This board is equipped with a complete set of throw-over switches, by which any of the lamps can be connected to the recording instruments or to the indicating voltmeters, ammeters or wattmeters at the will of the operator. The exact current consumption is thus determined and the necessary adjustments made very readily.

The company makes arc lamps, open and inclosed, for all sorts of currents—lamps for direct currents of 110 volts to 220 volts burning in multiple; for 220 volts to 550 volts burning in series-multiple; for constant current of 4 to 7 amps; for alternating current of frequencies of 7200 to 16,000 alternations per minute. All have to be tested, hence the need of the multiplied apparatus in the testing room. In addition to the current generated on the premises, wires from the town plant are led into the testing room, and a good many of the lamps are run on these circuits for continuous records and for testing. The currents being of 16,000 alternations on the one hand, and 6.8 amps. constant current on the other, the testing of lamps can be proceeded with at times when the rest of the factory is shut down, which in rush times is a great convenience.

The lamps are first tested until they run at the required current consumption without covers; they are then cased in, and run for several hours to develop any imperfections that would interfere with their good working after they leave the shop. The latest improvements in the construction of the lamps come from the developments of the past few years' experience of the users of the lamps. They meet all the weak points that have been shown to exist, which, as fast as discovered, have been studied and overcome. The constant trying of new devices suggested for doing this is another testing room job, and more or less new lamps are always burning there.

In the basement are located, in a room with glass slides, the dynamos furnishing current for testing. One is a 110-volt multi-polar machine for lighting the shops and lamp testing. Another is an alternating dynamo, rigged up for change of speed, in order to test out lamps of different frequencies. A third is a convertible 220-volt, or 550-volt machine, for testing direct-current lamps of these voltages, and the fourth is a series machine, for either 6.8 amps. or 10 amps., or anything between, used for testing and adjusting constant-current lamps. A feature worth notice is that the "spoolers" for winding the lamp solenoids are driven by individual motors from the 110-volt circuit, this method being adopted on account of the instantaneous speed control which it renders possible.

The principal personnel of the company and works consist of Mr. Roger Upton, president, an experienced man of affairs and an active official; Mr. Samuel C. Lord, secretary and treasurer; Mr. J. H. Hallberg, electrician and designer of the arc lamps manufactured at the works; Mr. M. L. Livingston, assistant manager and the traveling representative of the company, and Mr. Edgar Upton.



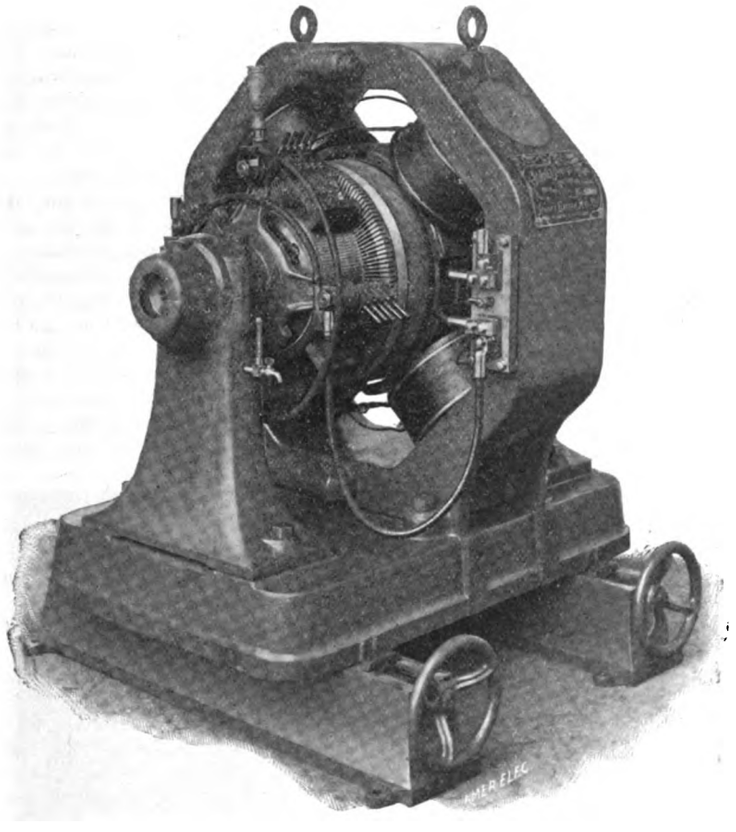
ARC LAMP TESTING ROOM.

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# New Apparatus and Appliances

### FOUR-POLE JENNEY GENERATOR.

The accompanying illustration shows a new Jenney type of four-pole generator. As will be seen from the engraving, the armature is of the slotted core type, with a proportionately greater number of slots than is usually employed in the construction of armatures of this type, which results in extremely smooth running, and prevents heating of the magnet poles. The armature coils, or conductors, are wound in forms and thoroughly insulated before being placed on the core. The commutator is of generous proportions and insulated throughout with high-grade mica. The brushes used are of the improved Jenney sectional carbon type, and are reversible. In this form of brush, the carbon is rigidly bolted to the brass holder, insuring a positive connection at all times, resulting in much less heating than is usually experienced with carbon brushes.



JENNEY FOUR-POLE GENERATOR.

The field cores are made of the best quality of annealed wrought iron, and are forced by hydraulic pressure into the field frame. The pole shoes are of cast steel, and screwed over the ends of the field cores, after which the field is bored out. With this construction there are no "butt" joints in the magnetic paths. In all except the small machines the field frame is parted vertically, which enables either half of field to be slid out away from armature, making all coils easily accessible.

The bearings are both self-aligning and self-oiling, and all brasses are made of phosphor-bronze. The makers of these machines, the Jenney Electric Manufacturing Company, Indianapolis, Ind., claim a very low temperature rise in all parts when working continuously under full load.

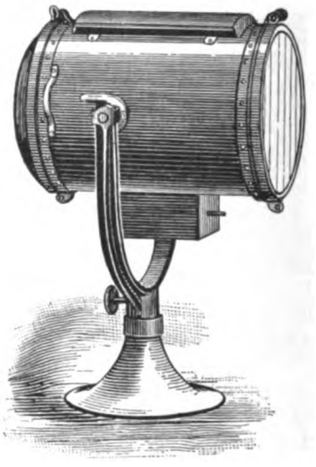
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### NEW ELECTRIC PROJECTOR AND SEARCH-LIGHT.

The accompanying illustration shows an improved type of electric projector and search-light, the latter only differing from the former in using in place of a mirror a silvered copper reflector and a set of condensing lenses, and being made in smaller sizes.

The apparatus consists of a cylinder of japanned iron or polished brass, in which is set the automatic focusing lamp, with carbons feeding horizontally and in such a position that the line of carbon is in the center of the cylinder, the lamp mechanism being in the box below. In the rear door of the cylinder is placed either a Mangin or parabolic mirror, as used in the English navy. Great care is exercised in the selection of these mirrors, which are ground and highly polished on both sides, and the silver is protected by a special backing of great heat-resisting power.

The lamp cases ride on a carriage in the box below the cylinder, and by means of a hand-wheel the entire lamp can be moved back or forward, so that the arc can be brought into the focus of the mirror, and thus the beams of light can be made convergent or divergent as occasion requires. The cylinder rests on its standard, and swings on its bearings, with a lock key to set the light in any desired direction. The contact between the base and standard allows the light to swing round the horizon without the twisting up of cables.



ELECTRIC PROJECTOR.

The apparatus for use on the roof of a pilot house, the light from which is entirely under control of the pilot, is of the same design as that above described, with the addition of a simple and efficient controlling device. This consists of a hollow tube running to the standard of the projector, through the roof of the pilot house; a wheel is attached to the end of this tube, through which runs a rod extending through the contacts, engaging with gears and sprocket carrying a chain over a second sprocket on the bearings of the cylinder. A lever handle at the end of the rod engages with a ratchet on the under side of the hand-wheel; thus, by turning the wheel, the light sweeps the horizon, and by moving the lever the gears are set in motion, and the light gets an up-and-down motion, from below the horizontal plane to the vertical.

These projectors are made by Chas. J. Bogue, 213 Center Street, New York, in all sizes, from the 8-in. diameter of mirror, taking 10 amps. and giving a beam effective at a distance of half a mile, up to the 32-in., with 100 amps., and throwing a light over six miles.

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### PREPAYMENT ELECTRICITY METERS.

A new prepayment electricity meter is being placed on the English market that embodies several novel features, and which has recently been adopted for use at Norwich, England. The principle of the Long-Schattner meter, under which name it is known, is shown by reference to the accompanying diagram. A is a lever pivoted at X, having suspended to its far end a copper plate B, which is immersed in a solution of copper sulphate. The box D is also of

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copper, and forms the negative plate, or cathode. C is a weight to balance the other side of the lever. K and E are cups to hold respectively the coins and the standard weights, the latter being placed in the cups to replace the coins removed by the collector. $F_1$ and $F_2$ are mercury cups, the former, or front one, being entirely filled with mercury, and the latter, or back one, half filled with mercury and having creosote oil on top. $H_1$ and $H_2$ are contact pieces, forming a bridge, across which

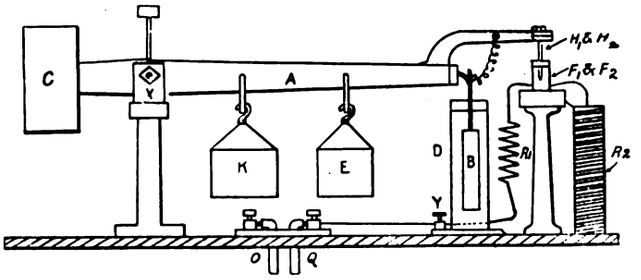



FIG. 1.—LONG & SCHATTNER METER.

the meter is shunted; and $R_3$ is a high resistance going from one mercury cup to the other.

The lever is overbalanced to start with, and when a coin is inserted it is brought down, thus establishing a short circuit across the mercury cups until an amount of electricity equivalent to the coin has been

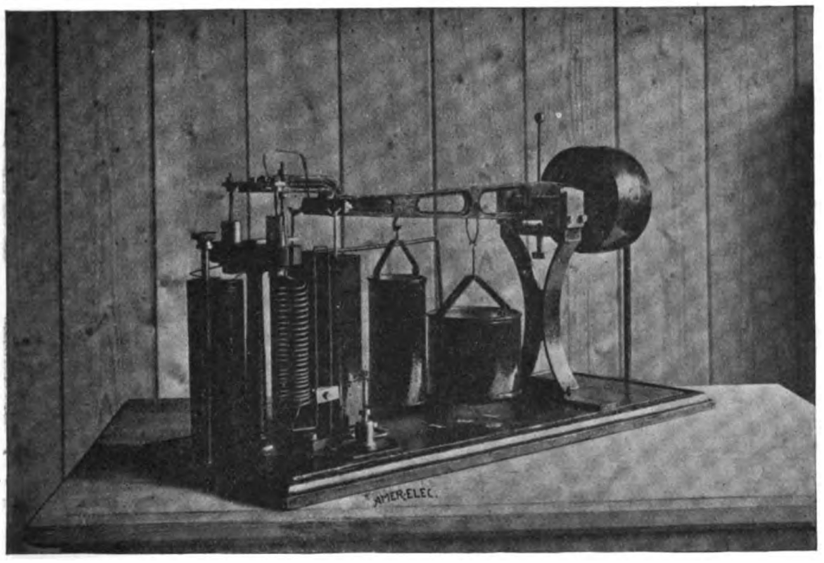


FIG. 2.—LONG & SCHATTNER METER.

used; that is, until the cathode B has been sufficiently lightened by the meter current to cause the lever to again overbalance, when the contacts H and F are broken and the current is forced to pass through $R_3$. Thus the circuit is never actually broken, the lamps continuing to burn quite dimly, and thereby forcing the customer to insert another coin to get any appreciable light at all; he has also to pay for the light which burns dimly, as the current for it passes through the meter and is paid for by the next coin inserted.

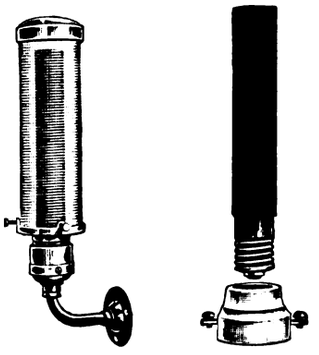
The inventor states that the drop of pressure across a 5-ampere meter on a 110-volt circuit at full load is only .1 of a volt. The meter is very easily calibrated, it being only necessary to calibrate for one load. He states that the troubles which have been experienced with other voltmeter meters are avoided in this case by depositing away from the plate which measures the current used; by bringing the current in at the top of the plate and out at the bottom of the box, thereby getting a very uniform distribution of current through the liquid and a uniform deposit; and by using a very low current density, thus avoiding breakage. The manufacturers of the Long-Schattner meter are Schattner & Co., Timberhill, Norwich, England.

### BRACKET ELECTRIC HEATERS.

The bracket type of electric heater illustrated herewith is designed for either direct or alternating current, and can be controlled by thermostatic switches in groups, so as to keep a room at any desired temperature. They are recommended by the makers for use in heating large halls, theaters, conservatories, etc., and are specially adapted for warming show windows to keep the glass free from frost. The heaters are usually made for .9 amps. on 110-volt circuit, but are also constructed for any voltage and desired consumption of current. Their dimensions are 2½ ins. in diameter by 8 ins. in height. The manufacturers are the Girard Electric Company, Philadelphia, Pa.

### A DIFFICULT CASE OF TUBE CLEANING.

The accompanying illustration, Fig. 1, is a partial view of the boiler plant at the Union depot at Columbus, Ohio, and shows a device which, under the most trying and difficult conditions, proved successful in thoroughly cleaning the tubes. This case was a peculiarly interesting one, for the reason, primarily, that various cleaners were used entirely without success, and the contract was finally refused by several manufacturers of boiler-cleaning devices. The Chicago Boiler Cleaner Company, Monadnock Building, Chicago, finally undertook the work, and after a close study of the conditions, evolved a special cleaner for the purpose.



BRACKET ELECTRIC HEATER AND COILS.

The boilers to be cleaned were three in number and of the Edgemoor pattern, and each containing seventy-five tubes. In this plant the water for the boilers is first run through a purifier, which, being probably as good a one as there is manufactured, removed practically all matter from the water except the chemical properties, which were held in solution. A deposit consisting of a nearly pure flinty sulphate of lime, about one-quarter of an inch in thickness, and adhering tenaciously to the tubes, was the only deposit encountered. It will thus be seen that it was not the thickness or weight of the scale, but its extreme hardness and adherence to the tubes that made it so difficult to remove.

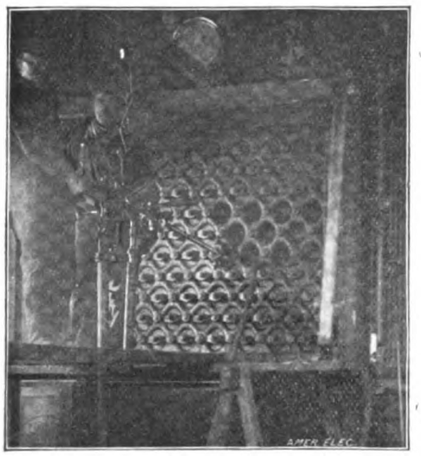
The Chicago Boiler Cleaner Company put into operation at this plant one of its cleaners modified to meet the special conditions. This consists of a steel barrel, 2⅞ ins. in diameter outside, and 2 7/16 ins. inside, with three slots cut in it 1 in. each in diameter and 2½ in. long, through which are set, in each slot, two boxes 1¼ ins. long, being admitted through the slot high enough to set snugly when inserted in the tube. In the center of these boxes are cutter wheels, with spiral knives running on a shaft. The core of the barrel is composed of a solid rubber spring, against which the base of these boxes rests, thus forming a cushion or spring, which gives way and allows the cutter wheels to pass any ordinary obstruction, or to clean a very crooked tube.

It will be noted from this that the cleaner has a flexible head. Screwed into each end of the steel barrel is a brass plug,

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which has a nut end, into which a thread is run. This permits the attaching of a driving shaft in one end, and to the other a plow-shaped device, which keeps the broken scale from the cutter wheels.

In these boilers the scale did not come away in pieces, as is usually the case, but the resistance was so great that the cleaner had to literally grind the scale to a fine dust. As an instance of its hardness, the operator stated that he found he could not clean more than fifteen or sixteen tubes before the cutter wheels, which are made of the finest kind of case-hardened



TUBES IN PROCESS OF CLEANING.

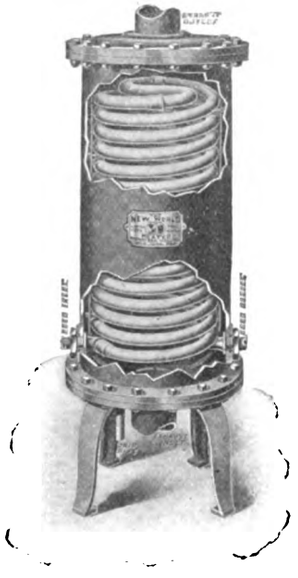
steel, would become badly dulled. From each tube cleaned this instrument removed an average of 30 lbs. of pure flinty sulphate of lime. The tubes were left absolutely free from even a suggestion of scale, were, moreover, polished until they shone without in any way being scratched or damaged, and were altogether in even better shape than when they were first installed. This is, in the opinion of the parties concerned, one of the most interesting cases on record.

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### RETURN COIL FEED WATER HEATER.

The new type of heater shown herewith, known as the New World return copper coil feed water heater, contains a number of departures from the old style of heaters, as can be seen from the engraving. It will be noticed that the water inlet and outlet are both located at the lower part of the shell, but on opposite sides, thus doing away with the many objections to the usual style of piping, where the outlet is generally at the top and on the same side of the heater as the inlet. The coil is made from seamless drawn copper tubing, and is of proper dimensions to give ample heating surface to heat the feed water to a temperature of 210 degrees Fahr., or to within 2 degrees of that of the exhaust under ordinary conditions.

The feed water is carried through this coil to the top of the heater; then, by means of an expansion return bend, which is so constructed that it does not in any way retard the flow of water or increase the friction, is passed down to the point of discharge at the bottom of the shell, meeting at that point the exhaust steam, and thus getting the benefit of the hottest steam as it enters and leaves the heater. The water in passing through this heater does not come in contact with any metal but



RETURN COIL FEED WATER HEATER.

copper, and therefore there can be no rusting nor any of the galvanic action which is so common where the water comes in contact with two different metals.

Among other features that commend the new heater is the perfect freedom for expansion and contraction, both lengthwise and spirally, as the coil is not confined in any way at the inlet and outlet connections, or at the bottom of the shell. The coils are practically jointless from inlet to outlet. When necessary to join the tubing, it is done by expanding and lapping the tubes, then brazing with hard solder—by this means the chance of leaking being reduced to a minimum. All coils are tested by hydraulic pressure to 600 lbs. pressure to the square inch before being placed in the shell. The heater shells of all sizes up to 300 h. p., inclusive, are made from cast iron and in larger sizes from steel, and tested to 50 lbs. pressure to the square inch. Each shell is provided with a stuffing box and gland nut where the coil connects with it, the stuffing box being so arranged on the outside of the heater that it can be packed while the heater is in use. The manufacturers are the Robertson Manufacturing Company, 208 Fulton Street, New York.

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### A SMALL DYNAMO.

The minature dynamo shown in the ac-



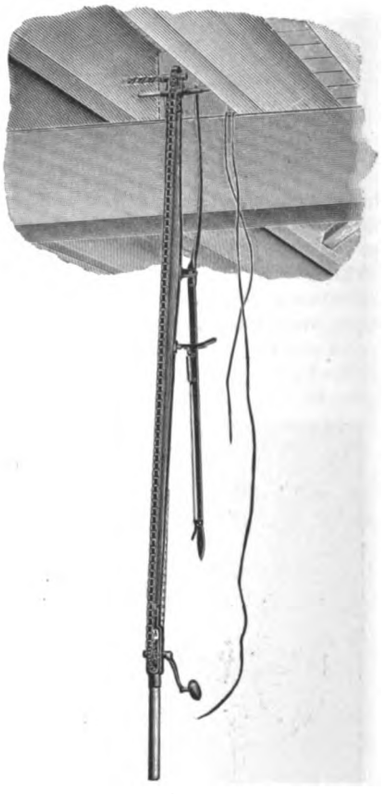
A MINIATURE DYNAMO.

companying cut has an output of 10 watts, but comprises all of the features of a large machine. The machine is wound for 2, 3, 5, 8 and 10 volts, and will light a 6-c.p. lamp, decompose water, charge storage cells, etc. The manufacturers are the T. & H. Electric Company, Elbridge, N. Y.

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### ELECTRICIANS' BORING MACHINE.

The boring apparatus shown in the accompanying cut is made especially for boring through timbers for the insertion of porcelain tubes. As will be seen, it bores the holes laterally through the timbers; the pulling in of wires is thereby much facilitated and their insulation is preserved, as there is no bending from one joint to another nor scraping of the insulation. No step ladder is required for boring holes, and the bit is extracted very simply by means



ELECTRICIAN'S BORING TOOL.

of a spring, which in one operation feeds the drill, and, when reversed, extracts it. The manufacturers are the G. & E. Electric Company, Binghamton, N. Y.

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### NEW TYPE OF SMALL GENERATING SET, WITH EIGHT-POLE GENERATOR.

Progression in the matter of the sizes of generating sets has been downward, as well as upward, and it is only recently that very small generating sets have come into the field. One of the latest is that illustrated herewith. The engine is single-cylindered, double-acting, with balanced piston valve. The frame is of such form as to practically inclose the running parts. Close regulation is secured by means of a shaft governor, which acts to change the point of cut-off from 0 to ⅞ of stroke.

The generator, which is attached to a common bed-plate with the engine, has a

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wrought iron magnet frame, and is provided with eight poles. The armature is of the type shown in the accompanying illustration, and is built up on a spider, the interior of which is perfectly smooth, offering no opportunity for the collection of oil or dust. Ventilation is effected by specially constructed vanes, forming air ducts between the laminæ of the core. These convert the armature into a blower and create a strong draft through the winding. The series winding of the field coils is of flat copper ribbon, the shunt winding being of wire. Both windings are

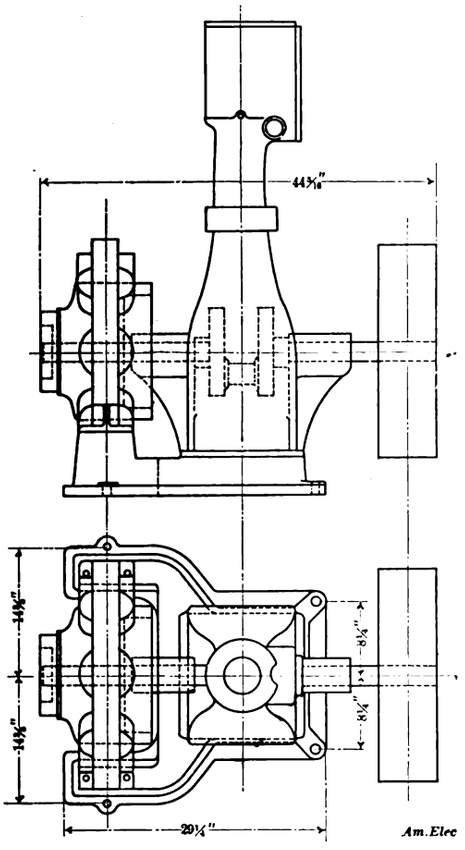



FIG. I. —SIDE, END AND PLAN VIEWS OF EIGHT-POLE GENERATING SET.

placed on the pole entirely independent of each other, and either may be readily removed. Both shunt and series winding have free circulation of air upon all sides. The generator is designed for sparkless operation under all changes of load, from no load to 25 per cent overload. The temperature rise for full load run of ten hours is limited to 90° F.

The set here shown consists of a 5 x 5 engine to run at 425 revolutions, and a 4½-kw. generator. The weight of the entire outfit is 1400 lbs. It forms one of a series designed and constructed by the B. F. Sturtevant Company, of Boston, Mass.

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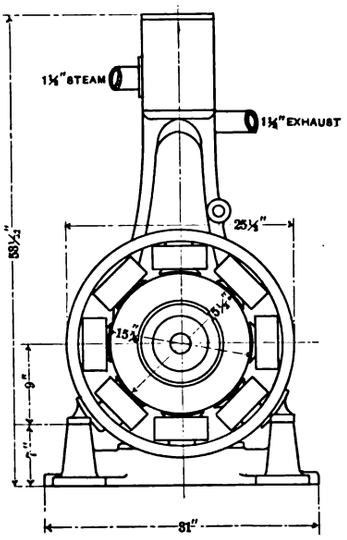
### SCARF PIN ELECTRIC LIGHT

The little novelty shown herewith, though not new in conception, is claimed to possess none of the defects which formerly so frequently gave dissatisfaction in the use of electric scarf pins. The lamp is of the high-efficiency miniature type and




ELECTRIC SCARF-PIN OUTFIT.

can safely be burned at a high brilliancy. The dry battery furnishing current is of the




"New Standard" Roche type, and is both efficient and convenient in size.

### A SMALL ARC LAMP.

The inclosed arc lamp, shown in the accompanying cut, has an extreme length of but 13 ins., and runs fifty hours on one trimming of 8 x 5/16-in. upper, and 2½ x 5/16-in. lower, carbons. In trimming, it is merely necessary to unscrew the small



ENCLOSED ARC LAMP.

nut shown at the bottom of the globe. The upper carbon is held in a contact bushing, which prevents it from feeding below a fixed point, at which current is cut off. The lamp illustrated, which is known as the "Tiney Lithian Lamp," is designed for connection on 110-volt constant-potential

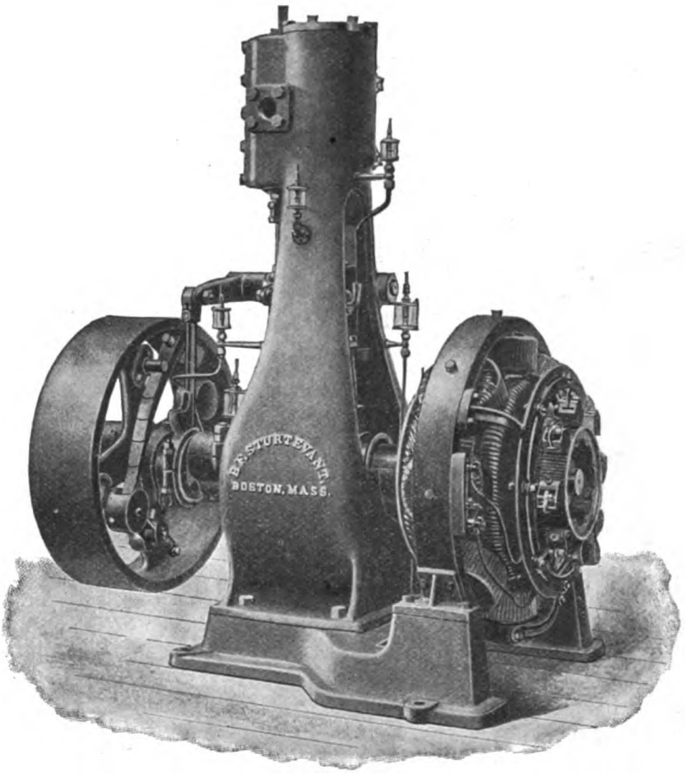



FIG. 2. —EIGHT-POLE GENERATING SET.

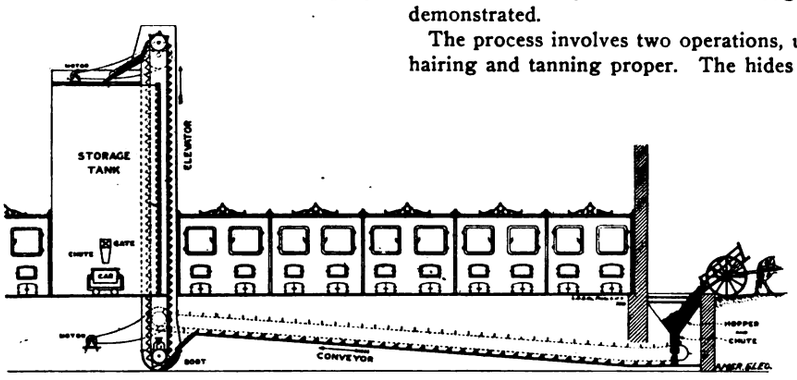
The manufacturer of the scarf-pin outfit illustrated is William Roche, 259 Greenwich street, New York.

circuits, and is made by the Safford Arc Lamp Manufacturing Company, 84 Terrace street, Buffalo, N. Y.

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### COAL AND ASH HANDLING MACHINERY.

The accompanying illustration shows diagrammatically the coal and ash handling plant now being placed in the new Mt. Vernon Street power station of the Union Traction Company, of Philadelphia. The plant is being installed by the Link-Belt Engineering Company, from general plans furnished by Mr. W. S. Twining, chief engineer of the Union Traction Company.




COAL AND ASH HANDLING PLANT.

The coal as dumped at the street level will automatically feed itself through a regulating gate to a horizontal conveyor, employing Monobar chain and an improved form of suspended flight. The advantages of this new form of flight are, that it cannot come in contact with the trough under any circumstances, and that the trough may be made of such depth as to render it impossible for the coal to get beneath the wear-receiving blocks attached to the ends of the cross-bars of the flights. The conveyor will deliver the coal to a continuous steel bucket elevator, erected half on the outside and half on the inside of a 200-ton steel storage tank.

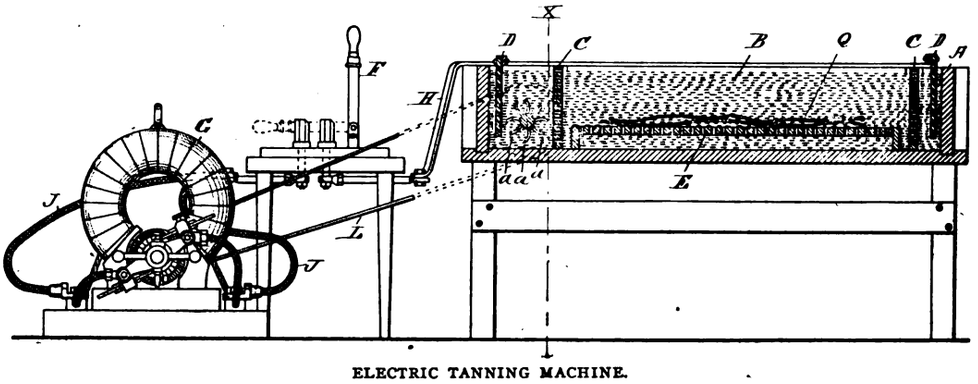
That is, the conveying buckets will ascend on the outside of the tank, and, after discharging their loads, will descend on the inside, a steel casing preventing the coal in storage from interfering with the returning line of buckets, and the side of the tank serving to hold the elevator rigidly in position. A track will be run in front of the boilers, and coal will be delivered to them by two Link-Belt one-ton side-dumping cars (one car for each half of the track), the storage tank being located alongside the middle of this track, and having its side fitted with a discharge gate near the bottom.

### ELECTRIC TANNING.

That electricity is of value in tanning has been known for some years from the investigations of German savants, but the practical application of electricity to commercial tanning is of recent origin. An apparatus for this purpose is illustrated herewith, being the first put on the market in this country, after, it is claimed, its commercial efficiency had been thoroughly demonstrated.

The process involves two operations, unhairing and tanning proper. The hides or skins are placed in an ordinary tank or vat containing a chemical solution, and while the skins to be unhaired are in the solution a proper current of electricity is passed through it and through the skins for a period of fifteen to twenty minutes. The current is then turned off, the skins still remaining in the solution for thirty minutes to one and a half hours, at the end of which time they are in condition to be removed and unhaired.

By the ordinary process from ten days to three weeks are required to prepare and unhair. After the hides have been unhaired and fleshed they are placed in a tank containing the proper bark extracts and a suitable current of electricity passed through the extract and the skins. The tendency of the current being to open the pores and allow the bark extract to thoroughly penetrate the skin, the tanning proceeds in a rapid and economical manner.




ELECTRIC TANNING MACHINE.

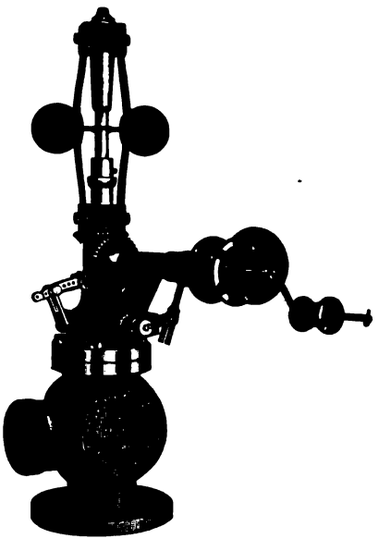
The illustration, which applies to both processes, makes clear the electrical connections and circuit, and shows the method of agitating the solution, the wheel, a, being in this case driven by belt from the dynamo furnishing the tanning current. This current passes between the electrodes, D, D, being controlled by the switch, F. C, C, are gratings, employed in order to obtain a proper distribution of the electrical current, and the hide is supported by a similar grating, as shown at E.

The manufacturers of the apparatus shown are the United States Leather Process Company, 138 Lincoln Street, Boston, Mass.

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### MONARCH STEAM ENGINE GOVERNOR.

The throttling steam engine governor shown in the accompanying illustration is adapted to any type of steam engine, and in addition, by a special fitting, can be ap- in addition, by a special fitting, can be very simply applied to the throttling type of gas engines.



MONARCH GOVERNOR.

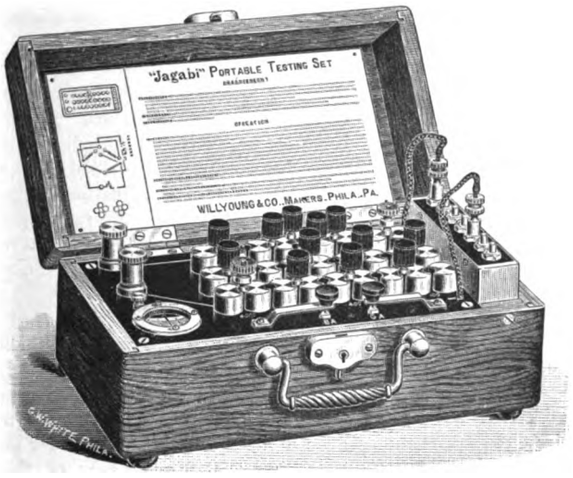
The valve throw of the governor is adjustable independently of the radial throw of the governor balls at normal speed of engine, thus enabling any desired closeness of regulation to be obtained on any type of engine. It includes an automatic safety stop, speed adjuster and valve lever, and all parts are standardized and fitted to gage.

The automatic stop device is positive and adjustable at any angle of the driving belt, from horizontal to vertical. The Monarch Governor and Machine Company, Indianapolis, Ind., is the manufacturer of this type of governor.

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PORTABLE TESTING SET.

The "Jagabi" portable testing set for resistance measurements, shown in the accompanying illustration, has a theoretical range of measurement from .001 ohm to more than 11 megohms. The outfit comprises a D'Arsonval galvanometer of latest design; a set of resistance coils, with a total capacity of 11,110 ohms; a reversible arm Wheatstone bridge, with a ratio of 1 to 1000; keys for galvanometer and battery, and six chloride of silver dry cells. All these parts are mounted in a handsomely finished mahogany case with lock and handle. The total weight is 7 lbs., so that the instrument can be carried from place to place very readily. Mr. James G. Biddle, 910 Drexel Building, Philadelphia, is sole selling agent for the "Jagabi" portable testing set, which is manufactured by Willyoung & Co., Philadelphia.

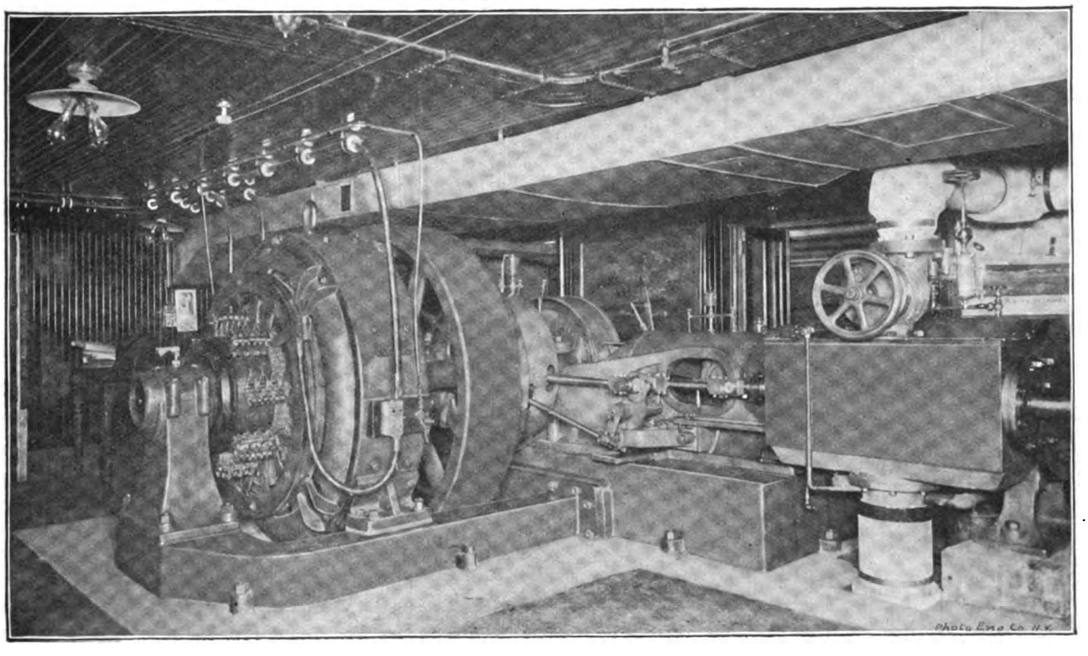



PORTABLE TESTING SET.

100-KW. DIRECT-CONNECTED GENERATOR.

One of the largest of the isolated electric generating plants in New York City is that, in their mammoth wholesale house, of the H. B. Claflin Company, the present capacity of the installation being 300 kw.

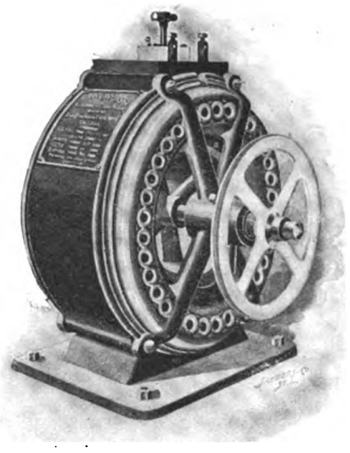
A recent addition to the plant has just been completed by the C & C Electric Company, of New York, and consists of one of its standard type eight-pole 100-kw. generators, direct-connected to a Buckeye engine running at 250 r.p.m. The generating set shown in the illustration herewith not only presents a very attractive appearance, but performs its functions in a most excellent manner. The compounding of the generator is so proportioned that it operates in perfect harmony with the other three older-type generators. The same company also furnished the very elaborate addition to the switchboard, and three iron-clad motors for operating freight elevators in the same building.



DIRECT-CONNECTED 100-KW. GENERATOR.

SPECIAL SLOW-SPEED LABORATORY MOTOR.

The laboratory motor shown herewith



SLOW SPEED LABORATORY MOTOR.

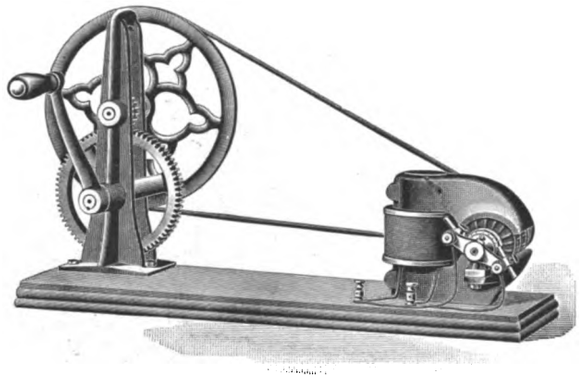
was designed, the manufacturers state, in response to a general demand for an alternating-current motor, giving more power than can be obtained from the small sizes of their ordinary induction motors, and less than their regular alternating-current motors of a ½-h.p. and upwards. The new type has speeds of 1200 and 1000 r.p.m. for 16,000 alternations, and 540 and 450 r.p.m. for 7200 alternations, the full load capacity in each case being 200 watts. The motor is intended for use on plate glass machines, dental work, small pumps and similar uses. Its extremely low speed gives it quite a strong torque at the pulley, and makes it much more convenient to arrange for di-

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rect belting or gearing without the intervention of countershafts. The manufacturers are the Emerson Electric Manufacturing Company, St. Louis, Mo.

### A MODEL DYNAMO.

The small dynamo shown in the accompanying illustration, which was designed

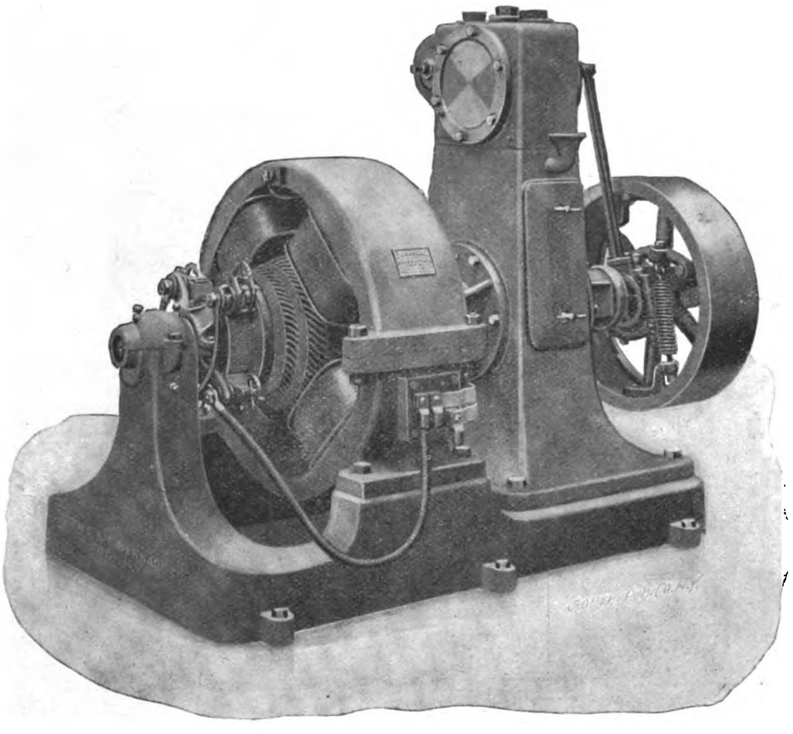


HAND POWER GENERATOR.

especially for the use of schools and students of electricity, will decompose water, light an incandescent lamp, charge permanent magnets, electro-plate, drive small motors, etc. It can also be used as a motor to drive light machinery, such as a sewing machine. It weighs 20 lbs., is 5½ ins. high and 9¾ ins. long through the armature shaft, and has an output of 75 watts.

### MARINE TYPE OF MULTIPOLAR GENERATOR.

The direct-connected marine type of generator shown in the accompanying cut in a photographic representation of a set recently installed on the U. S. Coast Survey steamer "Blake," by the E. G. Bernard Company, of Troy, N. Y. The set is similar to one installed by the same firm on the U. S. light-house tender "Mangrove," and a duplicate will be put aboard the Coast Survey steamer "Pathfinder," now being built for survey work along the Alaskan coast. The plant for the Coast Survey steamers includes, in addition,



MARINE MULTIPOLAR GENERATING SET.

The machine was originally made by its designer for his own use in electrical experimenting, but at the suggestion of the New York State inspector of school apparatus it was placed on the market, and is now largely employed for educational work. The present manufacturers are the Elbridge Electrical Mfg. Company, Elbridge, N. Y., of which Mr. A. E. Doman, the designer of the machine, is manager and electrician.

a search light and other modern electrical appliances, such as ventilating fans for the cabin, ward room and state rooms. As many ship electrical plants by their noise and vibration largely nullify their convenience otherwise, the naval officials were particularly pleased by the noiselessness of this type, its operation not being recognizable ten feet away on account of the absence of sound and perfect balance of the armature.

### THE "STANDARD" INDICATOR.

In the present time of close competition, no subject is of more importance to the engineer and steam user than the economical generation and use of steam. In this connection, no instrument is of more pronounced benefit than the steam engine indicator. In the "Standard" indicator, illustrated herewith, all complicated features have been carefully avoided, but without omitting necessary adjustments. In the general appearance no radical changes have been made, as will be seen in referring to Fig. 1. The cylinder is of the standard bore, .7978 of an inch diameter, to which is carefully fitted a bronze or steel piston. The piston-rod is hollow, and threaded to receive a swivel rod by means of which the pencil may be raised, for use on condensing engines. The same object may be attained, even while the indicator is under steam, by loosening the clamp screw or the drum-supporting arm, after which this arm may be placed in a different position on the cylinder. This feature also permits turning the "blow-holes" away from the operator, a point the user will appreciate. These holes are of ample area, and open direct to the atmosphere, so there can be no accumulation of pressure above the piston. The spring and method of attachment to the piston is shown in Fig. 2.

The drum is made of solid-drawn tubing, turned absolutely true and cylindrical. The method of changing the tension of the drum spring is remarkably simple. The shaft is provided with a pin with projecting ends. The upper end of the spring is attached to the knurled head, Figs. 3 and 4, to which is attached a steel tube, with slotted end

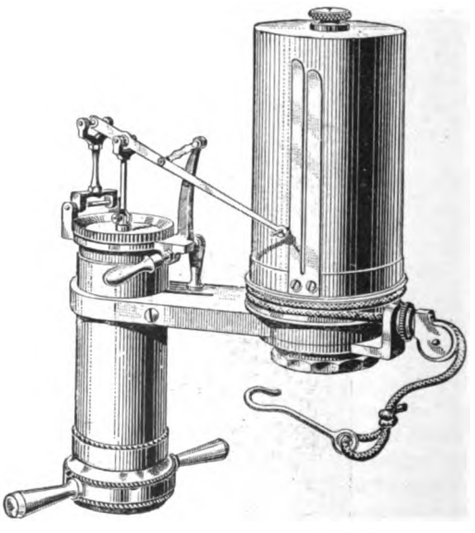


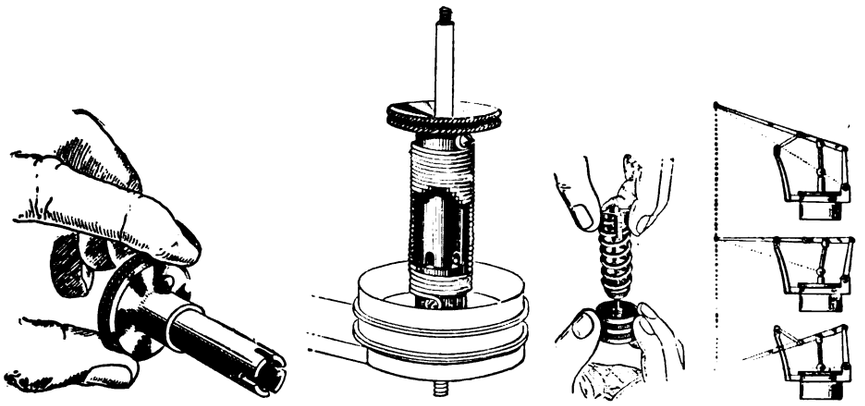
FIG. 1.—STANDARD INDICATOR.

to engage the pin. These slots are slightly wedge-shaped so that tension of the spring will hold it firmly in position without the aid of set screws or auxiliary springs. By raising the knurled head until the slots disengage the pin, any tension may be given the spring instantly. The style of spring used is shown in Fig. 4, and admits

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of a perfectly even spring tension throughout the entire drum rotation. This style of spring is not liable to break with use, and may be quickly made by any engineer.

The parallel motion is mathematically correct, and gives a straight line as shown in Fig. 5. All joints are properly fitted, have wide bearings, and the entire movement is nicely polished and blued. The balance of the instrument is highly polished and nickeled, and is packed in a fine mahogany case with all usual fittings. The manufacturers are the Lippincott Steam Specialty Company, 169 Broadway, New York.



FIGS. 2, 3, 4 AND 5.—DETAILS OF STANDARD INDICATOR.

## NEW BOOKS.

Lighting by Acetylene. Generators, Burners and Electric Furnaces. By William E. Gibbs, M. C. New York: D. Van Nostrand Company. 141 pages, 64 illustrations. Price, $1.50.

A collection of memoranda rather than a systematic treatise on the subject of the title, this little book is nevertheless of much value to those interested in the subject of acetylene, its preparation and use. The information is practical in its character, and numerous forms of carbide furnaces are shown in well-engraved illustrations, as well as the present commercial forms of acetylene generators. An appendix gives a complete list of carbide furnace and acetylene generator patents. As showing the newness of the industry to which the book relates, it is interesting to note that the first of several hundred patents on these apparatus only dates from 1895.

Shop and Road Testing of Dynamos and Motors. A Practical Manual. By Eugene C. Parham and John C. Shedd. New York: The W. J. Johnston Company. 538 pages, 163 illustrations. Price, $2.

A long-felt want has been a book dealing with practical electrical measurements as applying to machinery and conducting lines. This need may be said to be fairly met with respect to direct current measurements by the book under notice, which besides gives instruction in the theory involved, both fundamental and as relates to testing work. The first section of the book, consisting of 55 pages, is devoted to fundamental principles. The testing and use of instruments form the subjects of the second section, occupying 124 pages. The more practical portion of the work is introduced by a chapter descriptive of the series, shunt and compound machines, with directions for their testing, both for efficiency and faults. One chapter is devoted to compounding and another to tests for core loss, eddy currents, saturation, distribution and brush contacts. There is a chapter each on line and motor testing, and an appendix of tables having reference to the text.

The A B C of Electricity. By Wm. H. Meadowcroft. New York: American Technical Book Company. 107 pages, 36 illustrations. Price, 50 cents.

That this little book has entered into its sixty-fourth thousand is evidence that it meets a real need. As a very elementary treatise on electricity, and one designed to answer the questions generally put by the uninitiated, its great success is well deserved.

Petroleum Motor Cars. By Louis Lockert. New York: D. Van Nostrand Company. 218 pages, 92 illustrations. Price, $1.50.

The importance which automobiles are assuming renders this translation from the French a timely contribution to the subject. The first six chapters treat of the future of auto-locomotion, motor-car races, direct-combustion engines, gas and gas engines, petroleum, and petroleum cars. The succeeding eleven chapters are given over to descriptions of the various types of automobiles. One chapter is on accessories, such as brakes, lubricators and pneumatics, and two others on acetylene and acetylene motors. The descriptions of the various types of vehicles are in full detail, with references to accompanying illustrations.

## OBITUARY.

MR. RONALD T. McDONALD, president of the Fort Wayne Electric Corporation, died at Dallas, Tex., Dec. 24, of pneumonia, after a short illness. With the death of Mr. McDonald the electrical field loses a forceful character, who has been a large factor in its development from early pioneer days. Commencing with the organization of the Jenney Electric Company in 1881, he has continued a leader in electrical development, and at the time of his death was at the head of the Fort Wayne Electric Corporation and the Fort Wayne Lamp Works, besides being interested in many town and city lighting plants. One of the personal characteristics of Mr. McDonald was his devotion to the interests of Fort Wayne, which led to his memorable contest with the General Electric Company, when it endeavored to move the Fort Wayne electric works to Schenectady, and resulted in the organization of the rival Fort Wayne Electric Corporation.

## PERSONALS.

HON. GEO. O. PROCTOR, president of the Anchor Electric Company, was elected Mayor of Somerville by a very large majority at a recent municipal election.

MR. M. J. MARTINEZ, Mem. Am. Soc. M. E., has received the appointment of resident agent at Havana, Cuba, for the Snow Steam Pump Works. The business will be conducted under the style of M. J. Martinez, consulting and contracting engineer.

DR. LOUIS DUNCAN has been selected as engineer by the company which recently purchased the Fifth Avenue stage franchise, in New York City. It is the intention of the company to replace the stages with some form of automobile vehicle.

MR. S. DANA GREENE, assistant general manager of the General Electric Company, has been appointed by Governor Roosevelt of New York as the naval aide on his staff. Mr. Greene served on the "Yankee" during the late war as watch officer, and at present is a lieutenant-commander in the New York State naval militia, and the chief of staff.

PROF. SIDNEY H. SHORT, of Cleveland, sailed for Europe Dec. 13, and will make an extended tour through Great Britain and the Continent. While the object of the tour is principally recreation, Prof. Short has been asked by several professional bodies to deliver addresses on heavy electric railroading and high-speed traction, on which subjects he is held an authority in Europe, as well as at home.

CHIEF ENGINEER WALTER M. McFARLAND resigned from the Navy to accept a position as assistant general manager of the Westinghouse Electric & Manufacturing Company. Mr. McFarland for some years has been the assistant to Engineer-in-Chief Melville, in which position, and in service aboard ship, he has not only established a reputation both in this country and abroad as an accomplished engineer, but has shown that he possesses administrative abilities of a high character.

MR. W. J. CLARK, well known as the manager for years of the General Electric electric railway department, has accepted the position of general manager of the foreign department of that company, with headquarters in New York. Mr. Clark is peculiarly well equipped for his new work, not only through an extended acquaintance with foreign countries, but also through the possession of the personal qualities necessary for success in a cosmopolitan field. As the author of one of the most important books of the year—"Commercial Cuba"—Mr. Clark has displayed a grasp of detail in dealing with foreign commercial matters that will be of immense value in his present position.

## TRADE PUBLICATIONS.

MECHANICAL DRAFT.—The B. F. Sturtevant Company, of Boston, Mass., has just issued a second edition of its very suggestive pamphlet, Bulletin E, entitled "Draft Without a Chimney," which will be mailed on application.

ROUND-HOUSE TURN-TABLE.—The Westinghouse Electric & Manufacturing Company has issued a brochure in a very artistic cover on the "Modern Round-House Turn-table." A number of

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illustrations are given, accompanied by explanatory matter.

GAS ENGINES.—The New Era Iron Works, Dayton, Ohio, have issued a new catalogue, bound in an illuminated cover, and devoted to the "New Era" gas and gasoline engines. The text is both well written and instructive on the general subject of gas engines and their operation.

THE C. & C. ELECTRIC COMPANY, 143 Liberty Street, New York, has issued a new, enlarged and interesting issue of the bulletin, noticed here upon its appearance, treating upon its well-known iron-clad motors and dynamos. All those interested in this type of machines may obtain a copy of this bulletin (No. 127) upon request.

ANNUNCIATORS.—The Electric Appliance Company, Chicago, has made the Noxall annunciator the main text of a pamphlet, which also includes other house goods. The illustration of the Noxall drop shows that it contains but practically two pieces—the magnet and the needle—thus greatly reducing any chance of derangement.

PNEUMATIC TOOLS.—In a large-page catalogue, the Q. & C. Company, Western Union Building, Chicago, describes a long line of valveless pneumatic tools of its manufacture. Among the applications of those illustrated are to riveting, chipping, calking, beading flues, cutting stay-bolts, carving, lettering, etc.

IRON-CLAD DYNAMOS AND MOTORS.—Bulletin No. 127 of the C. & C. Electric Company deals with iron-clad dynamos and motors, generating sets, etc. Many applications of this type of machine are shown, and those interested in brush holders will find an illustrated description of the latest improved C. & C. reaction type.

ELEVATING AND CONVEYING MACHINERY.—The Aultman Company, of Canton, Ohio, has recently issued a catalogue descriptive of its various manufactures in the line of elevating and conveying machinery and other labor-saving appliances. The catalogue, which contains 136 pages, is very complete and is very carefully gotten up.

THE PEERLESS LAMP.—The Warren Electric & Specialty Company, Warren, Ohio, in a neat pamphlet gives an account of the recent unique prize contest instituted to bring forth a name for its incandescent lamp. Some hundreds of names were suggested, and that of "Peerless" was selected from these by a committee of three.

GRAPHITE.—The Joseph Dixon Crucible Company, Jersey City, N. J., has commenced the publication of a neat-looking periodical called "Graphite," whose object is to promote the use of the material from which its name is derived. Though thus frankly a trade publication, the matter contained is both interesting to the general reader and well written.

TELEPHONES.—In a new edition of its catalogue of telephones and telephone equipments, De Veau & Company, 27 Rose Street, New York, give some pages of practical information of value. The subjects are "Some Faults and Some Causes," "Telephone Line Construction," "Metallic Lines," "Ground Wires," and "Installation of Telephones." Another commendable feature is data on the e.m.f. and internal resistance of some of the primary cells listed.

CABLE TESTING APPARATUS.—The new catalogue of electrical measuring instruments recently issued by Mr. James G. Biddle, 910 Drexel Building, Philadelphia, describes a series of apparatus for testing resistance, insulation and capacity of aerial, underground or submarine cables. Portable outfits, as well as equipments for station use, are described. A copy of this catalogue (B) will be mailed to any address upon receipt of ten cents in stamps.

POCKET CALENDAR AND DIARY.—Mr. Henry L. Shippey, manager of John A. Roebling's Sons' Company, New York, is sending his friends with wishes for a happy and prosperous New Year a box containing a morocco case with twelve monthly diaries, the latter being so made that one can be removed and another easily secured in the case. The book also contains a miniature morocco-bound calendar scarcely larger than a postage stamp.

WESTINGHOUSE COMPOUND ENGINE.—The Westinghouse Machine Company, Pittsburgh, has issued an edition de luxe pamphlet, descriptive of its compound engine. In cover, binding, printing and illustration this beautiful production will compare favorably with the most pretentious of the holiday books put forth by the art publisher. The numerous half-tone illustrations are splendidly executed, and the text has more the character of a technical treatise than a trade publication.

AN ARTISTIC CALENDAR.—The H. T. Paiste Company, of Philadelphia, is issuing to the electrical trade a very artistic calendar for 1899. Many of our readers will recall a calendar which this firm distributed several years ago, illustrating a girl putting up her hair (A Switch?). Their 1899 subject is "Good Night," by Grust, and is a beautiful reproduction of the lights and shadows which make this painting famous. This handsome calendar will be sent upon receipt of four cents in stamps to cover expense of mailing.

THE M. O. ELECTRICAL LEATHER PROCESS COMPANY, 138 Lincoln Street, Boston, Mass., sends us a bright conceit in the shape of a post card having on the back a representation of a goose in a coop. Closer inspection shows that the neck of the goose is separable, and when pulled brings with it a sheet that had been concealed behind the coop. The latter contains the quotation: "The goose is not considered the bird of wisdom, yet the cackle of geese once saved Rome," with the comment, "If you will send for our illustrated catalogue it will show you how much we can save you."

TRANSFORMER DESIGN AND OPERATION.—From the General Electric press comes another fine specimen of the printer's art in the form of a pamphlet with the above title. The text includes a reprint of the Institute paper on "Alternating Current Transformers, from the Station Manager's Viewpoint," read by Mr. W. F. White, and a reprint of the paper read by Prof W. E. Goldsborough before the 1898 meeting of the National Electric Light Association. Another interesting feature is a description of the alternating current distribution system at Pueblo, Col., accompanied by plans.

TRANSFORMERS AND THEIR PROFITABLE USE.—Under this title the New York & Ohio Company, Warren, O., publishes a pamphlet, handsome in printing, paper and cover, and written by Prof. Dugald C. Jackson. Though professedly a trade publication, it is also an excellent technical treatise on the practical aspects of the subject. While the accompanying illustrations refer to the Packard transformer, the text has a general bearing, and will be found both useful and interesting by all users of transformers. In addition to the tests given by Prof. Jackson, a further section on this subject is contributed by Mr. Henry W. Wiswell.

INCANDESCENT LAMPS.—In a well-printed pamphlet bound in a cover of clean and artistic design, the New York & Ohio Company, Warren, O., illustrates and describes the various styles of its Packard lamps. A valuable addition to the catalogue consists of several tables containing lamp data, some of which is difficult to find in print. One of these gives the efficiency and life of lamps of various watt ratings at voltages above and below the normal, but within the range of commercial variation. Three other tables give the current in amperes taken by 3.1, 3.5 and 4-watt lamps of different candle-powers and voltages. An introductory section explains the bearing of these tables on the selection of lamps.

## BUSINESS NEWS.

W. G. NAGEL & CO. is a new firm, recently organized for the purpose of conducting a general business in electrical machinery, supplies and construction, in Toledo, O.

MR. HOWARD N. PATTEN, formerly with the Boston Edison Company, has accepted the position of electrical engineer with the Merrimac Manufacturing Company, Lowell, Mass.

THE ELECTRIC APPLIANCE COMPANY, Chicago, is calling particular attention to the Jenkins switch, which is the latest arrival in the field of snap switches and is sold at a low price.

PLUG SWITCHES.—The American Electric Heating Corporation, Cambridge, Mass., is making a plug switch containing a double-pole fusible cut-out, which is not only quick to install, but is claimed to be better for many wants than small knife or snap switches.

GEORGE WILLIAM HOFFMAN, Indianapolis, Ind., manufacturer of "U. S. Infallible Metal Polish," has opened a branch office in St. Johns, Newfoundland. Mr. Hoffman has branches in New York, Chicago and San Francisco, and is now reaching out for foreign trade.

THE SKINNER ENGINE CO., Erie, Pa., has recently shipped to Japan, for use in the Yokahama steel railway plant, a 9 x 17 x 15 tandem compound center-crank engine, equipped with the New Skinner self-oiling system. The engine will be direct connected to a Walker generator.

RHEOSTATS.—Mr. Charles Wirt, 1028 Filbert Street, Philadelphia, is making a specialty of field rheostats and also building a number of heavy and special designs. A searchlight rheostat recently shipped by Mr. Wirt is believed to be the largest constructed for this work, and has a capacity for continuous duty of 14 kw.

RED SEAL BOILER COMPOUND.—The Cherry Chemical Company, 1215 Filbert Street, Philadelphia, is much pleased with the business done during the past year with the "Red Seal" boiler compound. They anticipate, moreover, for the coming year even a heavier increase of business than met with in 1898.

MACHINERY AND MOTOR SPRINGS in large quantities have been turned out recently by the Cary Spring Works, 240 West Twenty-ninth Street, New York, on orders. The company reports that its customers express entire satisfaction with the springs furnished, which, it is stated, are of an especially high grade.

HENRY G. ISSERTELL, former manager of the Boston office of the Walker Company, has recently accepted the position of manager for the Middle Atlantic States of the Anchor Electric Company, of Boston. Mr. Issertell has opened an office in the Havemeyer Building, New York City, where he will be glad to receive his friends.

THE PHŒNIX IRON WORKS COMPANY, Meadville, Pa., has recently received an order from Laughlin & Co., Ltd., of Pittsburg, for three 300-h.p. tandem and one 600-h.p. cross compound engine. All these engines are of the condensing type, and will be direct-connected to electric generators in the new plant of Laughlin & Co.

MR. T. F. AHEARN, general superintendent, and Mr. S. P. Grace, electrical engineer, of the Detroit Switchboard and Telephone Construction Company, are in New Orleans attending to the construction and equipment of the People's Telephone Company, of that city. The new company has, it is stated, a list of nearly 3000 subscribers thus far.

THE SIOUX CORLISS ENGINE at the Omaha Exposition was awarded the gold medal over its competitors. This engine was built by the Murray Iron Works Company, of Burlington, Ia., and it was in continuous operation, twenty-four hours per day, during the greater part of the exposition, furnishing all the power used on the grounds.

THE UNITED STATES CARBON COMPANY, Cleveland, Ohio, reports a large increase in business, their mammoth presses being kept constantly busy on carbons for electro-metallurgy and electro-chemistry, which branch of trade is constantly demanding larger and more difficult carbons. Its carbons for inclosed arc lamps are also meeting with great success.

FEED-WATER HEATERS.—The Stewart Heater Company, Buffalo, N. Y., has received from the Bickford & Francis Belting Company a warm commendation of the Otis feed-water heater. One of these heaters installed seven years ago is stated to work entirely satisfactory at the present day, and with a cleaning once a year, continues to give the same excellent results that it did when new.

HAIR SPRINGS FOR ELECTRICAL INSTRUMENTS.—F. N. Manross, Forestville, Conn., has made a specialty of the manufacture of delicate springs for electrical indicating and recording instruments. The material used is a special bronze which possesses all the good qualities of steel and, of course, is not affected by magnet-

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ism. Orders from Japan and England have lately been received for these springs.

A NEAT POCKET CONVENIENCE.—The Standard Underground Cable Company, Pittsburgh, Pa., is presenting to its friends a combination foot-rule and wire gage for the pocket. One side of the rule, which is of celluloid and in three hinged parts, has two scales of inches, one divided into eights and the other into sixteenths. The other side gives the diameter and circular mils of wires from No. 4-0 to No. 22 B. & S. gage.

THE SHAWMUT FUSE WIRE COMPANY, of Boston, Mass., reports a large demand for its Monadnock knife switch. This switch is now much used by engineers and contractors who are looking for a high-grade article at a reasonable price. The company has recently supplied switches for some of the largest boards now being built in the West, and at the present time is working its factory night and day to fill rush orders.

THE FARR TELEPHONE AND CONSTRUCTION COMPANY, 357 Dearborn Street, Chicago, is congratulating itself on both the volume and profitable nature of its business during the past year. It has been patronized by the independent telephone companies of the United States and Canada in a flattering manner, and looks forward to the coming year as the most successful for the electrical trades that has ever been experienced.

OIL FILTERS.—The Columbus Filter Company, Columbus, Ohio, reports a very gratifying number of sales of their filter recently. Among other orders was a large shipment to the United States War Department for use at Fort Warren and at Indian Head, which order was secured only after a very severe test had been made of several types of filters. The Government has also placed an order for filters for the new Washington postoffice.

THE CHICAGO RAWHIDE MANUFACTURING COMPANY, 75 East Ohio Street, Chicago, reports that its business for 1898 shows a gain of at least fifty per cent over that of 1897, both in domestic and European orders. They believe that the users of rawhide beltings, pinions, etc., realize they make a saving in using rawhide goods, and so are just learning that a rawhide belt adheres to the pulleys so closely that it makes it a great saver in power.

THE COMMERCIAL ELECTRIC COMPANY, Indianapolis, Ind., reports the year just closing as one of the most successful in its history. The demand for its iron-clad type of motor has steadily increased, and the field it is now covering is a very wide one. The past year has seen its motors shipped to not only nearly every country of the American Continent, but also to Japan and other foreign countries. The company reports the prospects for 1899 as very bright indeed.

THE ROCKWOOD MANUFACTURING COMPANY, Indianapolis, Ind., is busier than ever. They have been working overtime for some weeks past. The many tests made in the past by power users generally have so thoroughly demonstrated the superior efficiency of the paper pulley manufactured by this company that it is universally recommended, and the manufacturer can rest assured that with this pulley in his plant he has secured the acme of known excellence in pulleys.

A NEW SWITCHBOARD will be furnished to the Providence central station by the Hope Electric Appliance Company, Providence, R. I. The switches to be used are the new type of Hope generator and feeder single-pole, double-throw jaw switch, which stop midway in the throw at the will of the operator. The switches will range from 200 to 1200 amps. capacity, and are from new and original designs, showing a decided advance in the development of switchboard construction.

THE KEYSTONE ELECTRICAL INSTRUMENT COMPANY, 1 Montgomery Avenue, Philadelphia, is daily receiving gratifying evidence of the growing favor with which its electrical measuring and indicating instruments are meeting from engineers and others most qualified to judge. The high place which these instruments are rapidly taking is due not only to the correct principles upon which they are based, but also owing to their excellent workmanship and their constant reliability.

THE WHEELER REFLECTOR COMPANY, 18 Washington Street, Boston, Mass., has had a gratifying increase in the volume of its business for 1898 over any previous year, and anticipates a still better record for 1899. The success with which the well-known Wheeler reflectors have met is the logical result of first-class workmanship, the best of material, ability to make prompt shipments, and the courteous treatment extended to the customers of this company by its salesmen and executive officers.

THE LOMBARD WATER WHEEL GOVERNOR COMPANY, Boston, reports that the demand for its governors is constantly on the increase. During last month orders were received for upward of twenty generators to regulate forty-one water wheels, which will develop 15,750 h.p. More than half of this machinery will be used in electric stations—principally in power transmission plants—and railway power stations, the balance being in textile and other manufacturing plants driven by water power.

MONTAUK MULTIPHASE CABLE.—The superintendent of the fire alarm department of Boston has made to Mayor Quincy a flattering report on the merits of the cable made by the Montauk Multiphase Company, 100 Broadway, New York. In his report the superintendent states that the multiphase cable is a valuable adjunct for use in any automatic fire alarm service depending on the action of thermostatic devices for its operation, and superior to the isolated thermostats used in the present automatic systems.

BOILER INCRUSTATION AND CORROSION.—Thomas N. Warley & Co., Philadelphia, Pa., give evidence of their confidence in the boiler compound of their manufacture by offering to send a half barrel anywhere in the United States subject to approval, and if the results are not satisfactory it can be returned without cost to the customer. This compound is claimed to not only remove and prevent the formation of scale, prevent pitting, corrosion in steel boilers, but has shown an actual saving of coal of from 15 to 70 per cent.

MACHADO & ROLLER, 203 Broadway, city, inform us that their business is showing a marked and very steady increase in volume. Their new dead-beat Whitney portable and switchboard instruments are being used and specified by a large number of the most prominent consulting engineers, and reports of very flattering character on the performance of their A. E. G. lamps are being received almost daily. They are always glad to have their friends call to see them and inspect the various new appliances that they bring out from time to time.

GORDON PRIMARY BATTERY.—We are informed that the business of the Gordon Battery Company, of New York City, is rapidly increasing, and friends of the company will be pleased to hear that it will declare immediately a semi-annual dividend of 4 per cent on the preferred stock from the net earnings of the six months ending January 1, 1899. The Gordon cells are being fast introduced into the telephone field and fire alarm service of the country. A majority of the railroads have adopted the Gordon cell for the operation of signals, and thousands are daily in use.

THE ANCHOR ELECTRIC COMPANY, Boston, Mass., has opened an office, for the greater convenience of its numerous patrons in New York City, in the Havemeyer Building, Cortlandt Street, telephone No. 3831, Cortlandt. Mr. H. G. Issertel, formerly of the Walker Company, is in charge of the office, and will be pleased to see all of his old friends at this office. It is the purpose of the Anchor Electric Company to carry a small stock in New York for emergency orders, and to do everything needful for the convenience of their customers in New York City and vicinity.

THE ORIENT ELECTRICAL COMPANY, of Youngstown, Ohio, is offering 1899 purchasers a new lamp (not a new name) which they guarantee to possess all the dsirable features to be expected in a first-class lamp. This company has recently equipped its factory with the latest and most improved instruments and appliances for the manufacture and thorough testing of the high-grade incandescent lamp referred to, which is manufactured by new processes and when put to the most thorough and practical tests has without a single exception given entirely satisfactory results.

CLIMAX STEAM JOINT CLAMPS.—Jas. McCrea & Co., 11 South Canal Street, Chicago, have received a flattering letter from the manager of the Warden Power Building, Philadelphia, concerning Climax steam joint clamps purchased a year ago, and which have been in constant use since that time. In every case, it is stated, where these clamps have been put on they have promptly stopped leaks, and the leaks have not opened up again. In some cases the clamps stopped leaks which otherwise it had been impossible to make tight on account of the vibration of the building.

BALL ENGINES IN THE NAVY.—Among recent sales of engines to the Navy Department by the Ball Engine Company, Erie, Pa., are two 180-h.p. tandem compound, each direct-connected to two 60-kw. G. E. generators, for the Norfolk Navy Yard, and an engine of the same size for the naval station at Bremerton, Wash. Also, a 300-h.p. vertical compound engine, direct-connected to two Siemens & Halske 300-kw. generators, for the New York Navy Yard.

THE COLUMBIA INCANDESCENT LAMP COMPANY, of St. Louis, has completed a number of important improvements in its factory and office, with which it hopes to be able to catch up with its orders and resume its usual prompt shipment in a short time. Mr. A. C. Garrison is the secretary and manager of the company, and these additions are another evidence of his vigorous policy, which leaves nothing undone that will contribute to the success of his company and to the satisfaction of its customers.

THE CENTRAL ELECTRIC COMPANY, Chicago, is in receipt of a great many flattering comments from the trade on their new general catalogue, of which the following is a sample: "We beg to acknowledge the receipt of a copy of your new general catalogue, and thank you for the same. It is a very complete and fine production in every respect. Kindly send us discount sheet." As the catalogue contains a quantity of valuable data outside of the merchandise illustrated, it is well worthy of careful examination and preservation.

INDUCTION SEWING MACHINE MOTOR.—The Emerson Electric Manufacturing Company, of St. Louis, calls attention to the fact that its improved induction sewing machine motors, having no wearing parts except the shaft, are particularly adapted for use by inexperienced persons, and the entire device is easily attached to any make of family sewing machine. The sewing machine is started, stopped and speed is regulated by a slight movement of sewing machine treadle. They further state that this is not in any sense an experiment, but is thoroughly practicable and fully guaranteed.

EXCELLO GRAVITY BATTERY.—For charging storage batteries the Excello Gravity Battery, manufactured by the Burnham Electric Company, 146 Franklin Street, Boston, is claimed to be superior to the ordinary bluestone cell by reason of its higher internal resistance. It is explained that this feature results in an economy of operation when the storage cell becomes partially charged, which the low resistance gravity battery does not possess. The manufacturers have on file a number of strong testimonials from users of Excello batteries, thorough satisfaction being expressed in each instance.

IDEAL ENGINES.—Recent sales by A. L. Ide & Sons, Springfield, Ill., of "Ideal" engines aggregate twenty-three in number, ranging from 8 x 10 to 16 and 26 x 20. Among the States represented are Michigan, Nebraska, Illinois, South Dakota, Oregon, Wisconsin, Minnesota, Missouri, Arkansas and Iowa. The list includes eleven direct-connected to electrical generators, and a large engine for a United States Government dredger. The Chicago & Great Western Railroad appears as a purchaser of two direct-connected compound engines, one 14 x 22 x 16, and the other 12 x 20 x 14.

CARBON BRUSHES.—The Le Valley Vitæ Carbon Brush Company, 45 Broadway, New York City, commences a new year with the confidence which success alone gives. During the past year its brush has not only met with large sales, but has established a favorable reputation far and wide that serves as a guarantee for the future. Among recent testimonials received is one from the manager of an important street railway, stating that the Vitæ brush had been run nearly 19,000 miles on one of its cars. As the life of the ordinary carbon brush is only about 2500 as a maximum, the weight of this statement is evident.

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VENTILATION OF BOSTON SUBWAY.—The thorough ventilation of the Boston subway, as well as the prevention of any possible moisture, is receiving the careful attention that it deserves. A thorough circulation of air is necessary, and it is to be secured by the operation of four special electric fans recently constructed and installed by the B. F. Sturtevant Company, of Boston. These are of the cone type, two of them 7 ft. in diameter and two 8 ft. in diameter. Each is driven by a special direct-connected motor, and operating together they have a capacity equivalent to changing the air in that portion of the subway which they connect once in fifteen minutes.

THE MASON vitrified, salt glazed, terra cofta conduit made by the Potomac Terra Cotta Company, of Washington, D. C., is salt glazed inside and out, and offers but little friction to the drawing in of the cables. The standard length is 30 ins., and they are made in two and four way patterns, with ducts of 3 and 3¾ ins. in diameter, capable of carrying the largest size cables. The sections are made and registered accurately by means of iron dowels. They are used extensively by the Postal Telegraph Company, the Chesapeake & Potomac Telephone Company, the United States Electric Light Company and the Potomac Electric Power Company, all of Washington, D. C.

TREATMENT OF BURNS.—Electricians well know that an electrical burn is apt to resist the usual remedies and require a long time to heal. There is, however, a remedy known as Vitogen, which, it is claimed, will quickly cure such burns, and as this claim is substantiated by many testimonials from reputable physicians, and put forth by one of the leading drug manufacturing firms of the country—the G. F. Harvey Company, of Saratoga Springs, N. Y.—it is well worthy of attention by those apt to be thus afflicted. The AMERICAN ELECTRICIAN for May, 1898, contains a report from the "Medical Journal" of a severe case of electrical burn which was successfully treated with Vitogen.

ELECTRICITY IN CUBA.—The Krajewski-Pesant Company have opened a wholesale and retail electrical establishment at O'Reilly 15, Havana City, Cuba, the manager of which is Mr. Norman H. Schneider, who was in the export department of the Western Electric Company, of New York, for a number of years. They are prepared to handle all kinds of machinery and electrical materials, and are sole Cuban agents for a number of prominent American manufacturers, and also represent the General Electric Company in London. Mr. Schneider will be pleased to hear from any of his old friends. He reports that they have several plants near Havana which they are overhauling and putting into going order.

THE CENTRAL TELEPHONE AND ELECTRIC COMPANY, St. Louis, Mo., calls attention to the fact that they are removing from 1123 Pine Street to 909 Market Street, St. Louis, at which place they will occupy the entire building, and will be prepared to give their customers even better service than in the past. Mr. J. S. Cuming made a flying trip to Chicago last week, and called at the Western office of the AMERICAN ELECTRICIAN. He stated that they had done an unusually large business during the past year, and that they were never better prepared to handle large orders with facility and promptness than they are now in their new quarters. The many business friends of this concern will be pleased to learn of its growth and progress.

A LAMP NOMENCLATURE CONTEST.—The Warren Electric & Specialty Company, Warren, Ohio, as a result of a prize contest to suggest the most appropriate name for the high-grade lamp of their manufacture, has adopted the word "Peerless." Several hundred different names were suggested, and from these the committee to whom the suggestions were referred, decided upon the word "Peerless," and a prize of $50 was divided among the three persons who suggested this name. The second prize of $30 was divided among seven persons who suggested the word "Wesco;" a prize of $20 among five people who suggested the word "Liberty," and a fourth prize of $10 divided among four contestants who suggested the names of "Aladdin," "Aurora," "Eclipse" and "Encore," respectively.

A GERMAN P. & B. FACTORY.—Owing to the great increase in its foreign trade, the Standard Paint Company, of New York, decided some time ago to build a branch factory at Hamburg, Germany. This factory was begun in July, 1897, and completed in 1898, since which time all the compounds and apparatus manufactured by the Standard Paint Company in this country have been supplied by the branch factory at Hamburg. These include not only the P. & B. paint, tape, varnish, and other goods which pertain directly to the electrical trade, but also P. & B. rubberoid roofing, P. & B. building sheathing and insulating papers, and P. & B. preservative roof and structural paints. It is a good indication of the standing of this company's products that material which has proved so popular in this country is equally popular abroad.

PENBERTHY INJECTORS.—An injunction, with cost, has been granted to the Penberthy Injector Company, Detroit, Mich., against a concern which has been offering for sale an injector under the name of the "Penberthy injector." The court decides that the defendants by the formation of a company under a similar name, their location on the same street, and their persistence in using the word "Penberthy" upon their goods and in their business and corporate name and in all their advertising matter, thus leading buyers and people dealing with the concerns to think that the defendant corporation was a continuation of complainant's business as successor or otherwise, all led to the conclusion that they intended to appropriate a portion of complainant's good will and good reputation, and to divert the complainant's business to the defendants.

CLING-SURFACE.—The great extension of the business of the Cling-Surface Manufacturing Company, now at 146 to 152 Virginia Street, Buffalo, has compelled it to move from its former quarters in Court Street to the above address. Although the new factory is ten times as large as the former establishment, all available space therein, including a spacious laboratory, is used for manufacturing the daily output. That the sphere of usefulness of "Cling-Surface" is a large one is further attested by the fact that the output is being daily shipped to all parts of the globe, orders being received from South America, Europe, Asia, South Africa and Hawaii. Engineers who realize the tremendous loss of power every day and every hour in the day must necessarily be interested in a product which not only allows belts to run so slack that they almost touch, but secures an increase of power.

STORAGE BATTERY SUPPLY COMPANY.—Storage batteries and accessories have been manufactured by Theodore D. Bunce, of 239 East Twenty-seventh Street, New York, for the past seven years, and the business has assumed such proportions as to cause Mr. Bunce to form the Storage Battery Supply Company for the purpose of handling the increasing trade. Mr. Bunce is president of the new company, and states that a larger stock of cells for rental will be carried than heretofore, and that the company will extend the lines of manufacture previously conducted by him, which include storage cells and repair parts of every description, medical and dental outfits, carriage lighting outfits, etc. A seasonable specialty to which attention is particularly called is a complete outfit for lighting Christmas trees and for table decorations on special occasions.

AMERICAN ELECTRIC VEHICLE COMPANY, Chicago, announces that the contract and agreement heretofore entered into between it and the Indiana Bicycle Company, whereby the latter company undertook to build the electric vehicles for the American Company, was canceled and terminated Oct. 4, 1898, and that the Indiana Company has now no authority to build or sell the American electric vehicles, or vehicles made in accordance with the patterns or under the patents of the American Company, and has no right to deliver said vehicles, although contracted for or commenced during the continuance of said contract. The announcement states that the vehicles of the American Electric Vehicle Company are covered by letters patent owned by that company, and that purchasers of such vehicles from unauthorized parties will render themselves liable for infringement.

A "STERLING" SPECIALTY.—The beautiful white enameled dial of the Sterling Supply & Manufacturing Company, of New York, is coming to be seen more and more often on the cars of American street railways, small, as well as large, though hitherto a favorite among the larger companies chiefly. Its exclusive use by the Metropolitan Street Railway Company, of New York, is, of course, almost in itself a guarantee of its excellence and satisfactory qualities, since it is well known that every possible "leak" is avoided on the Metropolitan system, and no leak is so important as that of earnings. The Sterling trip and totalizing alarm registers are made with either the plain white disc referred to, or the dial indicator, as may be preferred, and are arranged for either cord or rod connection, as desired. All of the auxiliary equipment devices are of the finest quality and most carefully made.

MOTOCYCLE STORAGE BATTERIES.—J. K. Pumpelly, manager of the Crofton Storage Battery Company, Chicago, who has had sixteen years' experience in storage battery work, has produced two types of batteries especially designed for motocycle work. In one the plates are very thin and light but strong and tenacious, excelling in endurance the noted French "Fulmen" battery and equaling it in efficiency. The other is a battery of an entirely new type, in which the negative electrode forms the containing jar, thus doing away with the expensive rubber jar. This battery is very strong and light, and can be set up in any wooden box or frame suitable to go into the motocycle receptacle made for the purpose. The battery electrode consists of only two elements, is 4 ins. in diameter and 11 to 12 ins. in height. The two electrodes, positive and negative, of this surface and weighing 13 lbs., has a capacity when fully charged of 100 ampere hours. Machinery is now being made to make these batteries.

STREET RAILWAY SUPPLIES.—The Sterling Supply & Manufacturing Company, New York, has recently enlarged that portion of its plant devoted to the manufacture of insulating material and commutator bars, and large quantities are being turned out to meet a greatly increased demand. This insulation is a special compound molded while in a plastic state under hydraulic pressure. It is hard, tough and impervious to weather, and has high insulating qualities. In addition to these specialties, the Sterling Company also manufactures a large line of street railway supplies of various kinds, including the Sterling sand box, conductors' badges, the Sterling counter for counting reciprocating or rotary movements, including revolutions of wheel axles, machinery, etc., a wire-measuring machine, and a winding machine for recording revolutions of spindles and armature bobbins. With so large a number and variety of specialties, it goes without saying that the Sterling Company is of great use to street railway purchasers.

MURPHY AUTOMATIC SMOKELESS FURNACES, made by the Murphy Iron Works, Detroit, Mich., are to be attached to the twelve 375-h.p. Wickes vertical boilers for the Armour Company's new central station plant at Chicago Stock Yards. The Raritan Copper Company is now installing at its new works at Perth Amboy, N. J., a boiler plant of 1400 h.p., equipped with Murphy automatic smokeless furnaces. Coal and ash handling machinery will be attached in both the above cases. Other recent orders are for eight furnaces for the National Carbon Company, four of which are for new boilers and four displace another type of furnace; three for the Lakeside Hospital and three for the Upson Nut Company, all at Cleveland, O.; two for the J. C. Hubinger Co., Keokuk, Ia., for their plant at Quincy, Ill.; six for John Morrell & Co., Ottumwa, Ia.; six for the Cincinnati Street Railway Hunt Street Station, and four for the Cambria Company's works at Johnstown, Pa., making its twenty-seventh order and a total of 144 furnaces sold the latter company since May, 1890.

TELEPHONE EXCHANGES ABROAD.—L. P. Smith, of the Ericson Telephone Company, 20 Warren Street, New York, who has just returned from an extended business trip through Europe, states that the telephone system of Sweden, equipped with the Ericson telephones of Stockholm, is unquestionably the best in the world. Stockholm has the largest and most complete single telephone exchange in the world, there being 21,600 subscribers. In the principal hotels in Stockholm each room has a telephone directly connected with the exchange. The expense to each subscriber is from $10 to $16.60 per year. In

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Copenhagen is an exchange of 12,000 subscribers lately completed and equipped with the Ericson telephone. The Ericson Company, of Stockholm, is also building an exchange in St. Petersburg for the Russian government. They are also filling an order of 10,000 telephones for the National Telephone Company, of London. After visiting the principal countries of Europe Mr. Smith is of the opinion that the telephone system in this country stands next to that of Sweden in completeness and efficiency.

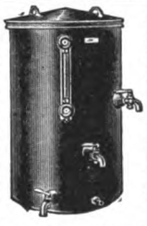
CORRESPONDENCE INSTRUCTION.—It is safe to say that there is no system of education, aside from a university course, so well suited to the wants of all connected with the electrical profession and of those desiring to enter it, as correspondence instruction. This system has been gradually improved and developed until the present high standard has been attained. The courses in the United Correspondence Schools, 154 Fifth Avenue, New York, now represent the perfected result of seven years' experience in instructing by this method. The public has not been slow to recognize the advantages to be obtained by enrolling in these schools, and vast numbers of mechanics, engineers, attendants, superintendents, salesmen, firemen, motormen and others testify to the benefits which they have received from their scholarships. Special courses are offered in electrical engineering (complete), electrical station engineering, electric lighting, electric railways, telegraphy, telephony and electro-plating. Mechanical drawing and machine design, including the design of dynamo electrical machinery, are also taught.

LORD'S BOILER COMPOUNDS.—A recent number of the "Boot and Shoe Journal" contained a very interesting article giving percentages of failure in the wholesale boot and shoe trade, and concluded by stating that only one firm in a thousand can point with pride to a record of thirty years in that line of business. This percentage may also apply to many other staple trades, and makes the record of Mr. Geo. W. Lord, Philadelphia, Pa., of Lord's boiler compound fame, seem phenomenal. Mr. Lord has devoted his entire time and ability for the last thirty years to the one business of chemically treating feed-water for steam boilers, and as the result is now recognized by nearly all authors on steam engineering as an eminent authority on the subject. From the appearance of his general offices, mill and shipping rooms, one would judge that his life-long labors have not been in vain, as everything seems to be pushed to its full capacity. Mr. Lord stated, in a recent interview, that his business has increased year by year, not even decreasing in the late hard times, but has been greater in volume in 1898 than in any previous year.

THE MICA INSULATOR COMPANY, of New York, Chicago and London, manufacturers of "Micanite" materials for high-grade insulation, reports a gratifying demand for its commutator rings. The company makes a specialty of manufacturing molded insulation, and is now turning out for some of the large manufacturers of electrical machinery molded rings all in one piece. This pattern of ring is the most difficult insulation to manufacture, but as it comes from the machinery of this company it is as perfect as a stamped piece of steel ware, and has the same metallic ring. Electrical manufacturers will do well to write the company, sending their blue-prints for estimates. Another form of insulation of which this company has made a specialty is the armature trough or slot, which is now in use by many of the manufacturers of motors for crane work and by those who require a heavy insulation which will stand at very high voltage. While this form of insulation is a trifle more expensive than the common red paper and "mica," yet those concerns manufacturing machinery which receives such rough usage have found it necessary to get the best possible insulation for their armatures.

THE LARGEST VOLUME OF BUSINESS ever taken in a similar period by the C & C Electric Company, of 143 Liberty Street, New York City, is reported by that company as having been transacted during the first week of November. The company states that this business did not consist of comparatively few large orders from large centers, but was made up of orders of average size from nearly every quarter of the globe. An order, the history of which is rather interesting, was one from the R. H. Hood Company, of New York City, for two 120-kw. belted generators, with all switchboard equipment, and iron-clad, back-geared motors, aggregating about 100 h.p., for use in connection with apparatus for removing all the ashes from Greater New York to Riker's Island for the purpose of raising the level of that island. The C & C Forbes marine generating sets, comprising a C & C generator (either open or closed type), direct connected to a Forbes vertical en-

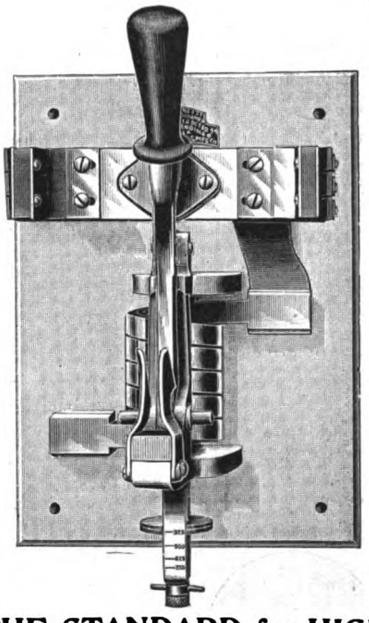

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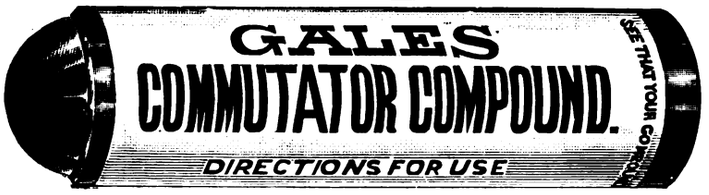


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gine, are meeting with a steady demand for lighting yachts, ferryboats and other small and medium-sized craft. These sets are made in sizes ranging from 2½ to 17 kw. output, and are fully described in circulars published by the C & C Electric Company.

BROADWAY BRAKES.—Nearly every one who rides on the Broadway cars in New York City wonders at the power and delicate adjustment of the brakes in use thereon, by means of which a car may be run in a crowded street at considerable speed, almost to the point of touching a wagon or another car in front, and yet may be instantly brought to a complete stop by a slight movement of the gripman's hand. The brake which accomplishes this result is the invention of Thomas Millen, master mechanic of the Metropolitan Street Railway Company, and is made by the Sterling Supply & Manufacturing Company, New York. It is a simple hand brake, with one essential peculiarity, namely, that the usual movement of the brake rod is multiplied in power through a gear and pinion working in the ratio of 5 to 2. On the gear axle is a double sprocket wheel, which operates the brake levers by means of a chain. Another feature of the entire brake apparatus is that the brake shoes are run very close to the wheel, so that a slight motion only is necessary to bring them to full bearing, and the wear in the brake shoe is taken up in the chains connecting with the brake rod. Another well-known device made by the same company is a street car fender, also in use in New York and other cities. This is a track fender, not a dashboard fender.

THE PELTON ENGINEERING COMPANY has been incorporated at Cleveland, Ohio, by W. H. Pelton, H. H. Holding and Allan Bassett, and has acquired all the available assets of The Cleveland Electric Trading Company, formerly doing business at 806 The Cuyahoga, and of The Cornman Company, assigned. It is the purpose of the new corporation to act as contracting engineers in the erection of steam and electric plants and as manufacturers' agents for a few first-class lines of apparatus. They have already some very good agencies, and have considerable work on hand. They will also carry a full line of station supplies, making a specialty of repairs and supplies for Brush arc apparatus. The company expect to locate very shortly at 1076 Hamilton Street in the buildings now occupied by The Parish & Bingham Company, and will be exceptionally well located for the handling of general electrical business. Regarding the personnel of the firm, Mr. Pelton has had some years of active experience handling electrical machinery, and in the design and erection of power station work, and is well fitted for handling very heavy erection. Mr. Holding, the vice-president of the company, graduated from Rose Polytechnic Institute in '87 and entered the engineering department of the Thomson-Houston Electric Company, remaining with them until their consolidation with the Edison interests. He then entered the engineering department of the General Electric Company, remaining with them for several years as an expert, during which time he installed several very large plants. Mr. Bassett, secretary of the company, who will take the sales department, is a young man who has already an exceptionally wide acquaintance among central station men and the electrical trades. He is thoroughly familiar with the principal systems of light and power distribution, and has also had considerable experience pioneering electrical enterprises. Manufacturers who are not now represented in the central section are invited to correspond with this company.

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Without a thought of pride;
I part the gathered thoughts of men,
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I set the soul of Shakespeare free,
To Milton's thoughts give liberty,
Bid Sidney speak with freer speech,
Let Spenser sing and Taylor preach.
Though through all learning swift I glide,
No wisdom doth with me abide."

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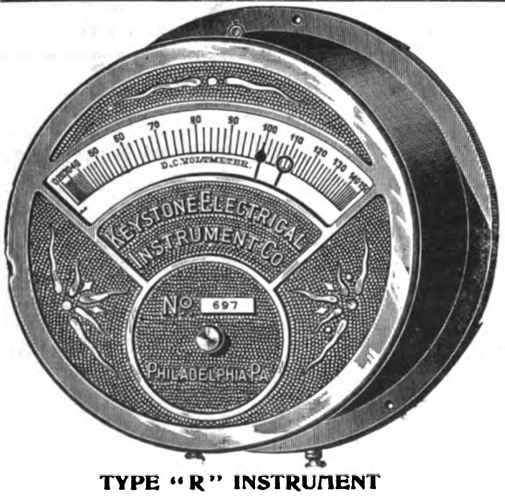
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# American Electrician.

Vol. XI. New York, February, 1899. No. 2.

## ELECTRICITY IN A MEDICAL CLINIC.

### ELECTRICITY AT THE POLHEMUS MEMORIAL CLINIC.

The average isolated electrical installation partakes of a certain sameness, which makes descriptions in this day of enlightenment on engineering matters of this nature somewhat tedious, but in the case of the plant which has been chosen as the text of this article, the writer believes that the exceptional thoroughness of the installation, the unique applications of electricity which are employed and the numerous and highly ingenious methods of convenience and economy which are incorporated into its construction, will render a description interesting to those who are in search of something new.

The building in which this plant is installed is located on the corner of Amity and Henry Streets, Brooklyn, N. Y. The cost of erection was defrayed from funds donated by the widow of Henry Ditmas Polhemus, and is wisely managed by Mr. Wm. B. Davenport, attorney of the estate and president of the Clinic. The generous donation was sufficient to enable the highest grade of electrical and mechanical engineering to have a free field.

The building is an imposing structure of eight stories high and is thoroughly fireproof. The architecture is French Renaissance. The frontage on Henry Street is sixty-eight feet and the Amity Street frontage is ninety-two feet. The walls, floor, roof, and many of the partitions are constructed of steel girders with masonry enclosure. A complete system of ducts is provided for steam and water pipes, for ventilation and for electric cables.

The boiler room of the plant is located under the sidewalk on Amity Street, and the sidewalk under Henry Street is devoted to a coal bunker of 300 tons capacity. From the bunker to the boilers runs an overhead trolley (Fig. 4), similar to that used by wholesale handlers of beef. Instead of sides of beef this trolley enables the ready movement of a dumping bucket which will easily carry 500 lbs. of buckwheat coal. This bucket is readily filled from the coal bunkers by an appropriate chute, and before its contents are finally dumped on the boiler-room floor, it is weighed, for the track is provided with a section which is connected to a Fairbanks scale. A record is made of the weight of every bucket of coal that is delivered to the furnace.

A similar trolley system is used for the removal of the ashes. These are placed in cans, and by means of a trolley are transferred to a little hydraulic lift which raises them to the level of the sidewalk.

The ashes are weighed as well as the coal, a limiting ratio of the weight of the ashes and coal is set, and the fireman is expected to keep close to these figures. With the coal that is now in use, which is a good grade of the buckwheat variety, the ashes from three tons of coal must not exceed

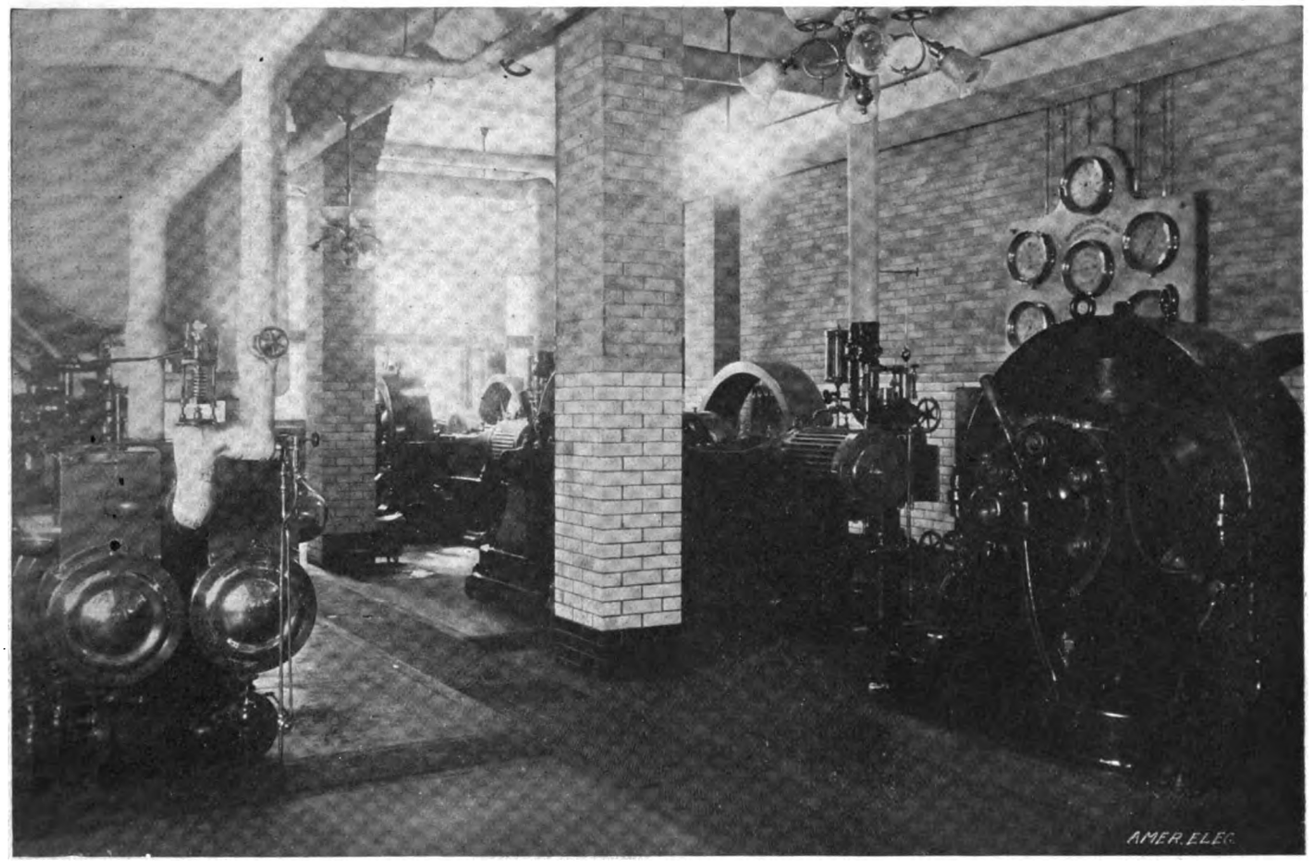



FIG. I.—VIEW OF GENERATING ROOM.

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900 pounds. The average coal consumed during cold weather is 3½ tons per day.

In order to keep up to the ratio which has been set, it is necessary for the fireman to keep a thin fierce fire under the boilers and to fire frequently. The fire carried is scarcely more than four inches thick and the "spread firing" method is used. This is essential, for a thick fire of fine coal offers great obstruction to draft as it tends to pack closely.

The boilers are of the Babcock & Wilcock type. There are two of them, rated at 150 h.p. each. They are provided with a brick setting and the grate surface underneath each of them is 35 square feet. The fires are cleaned twice a day, and this operation is much facilitated by means of a dumping grate. An argand blower is fitted for one of the furnaces, which is pressed into service in cold weather, since the present boilers are now taxed to their fullest capacity.

The flue gases pass to a breeching at the back of the boilers, which takes a downward drop of about 6 ft., and then passes to a 145-ft. stack, 48 ins. in diameter. The breeching is covered with magnesia, and it may be added that insulating covering is profusely used throughout the plant, and that even the water supply pipes are thus covered, the idea being to stop annoying drips from pipes sweating and also as a matter of appearance. A general view of the boiler room is given in Fig. 4.

The pressure carried in the boiler is 100 lbs. It is fed with city water, which has proved very satisfactory. Brooklyn water is said to be softer than New York water, but it contains more material in suspension. This water is passed through a filter which removes a great deal of foreign matter. The filter used is very satisfactory and was

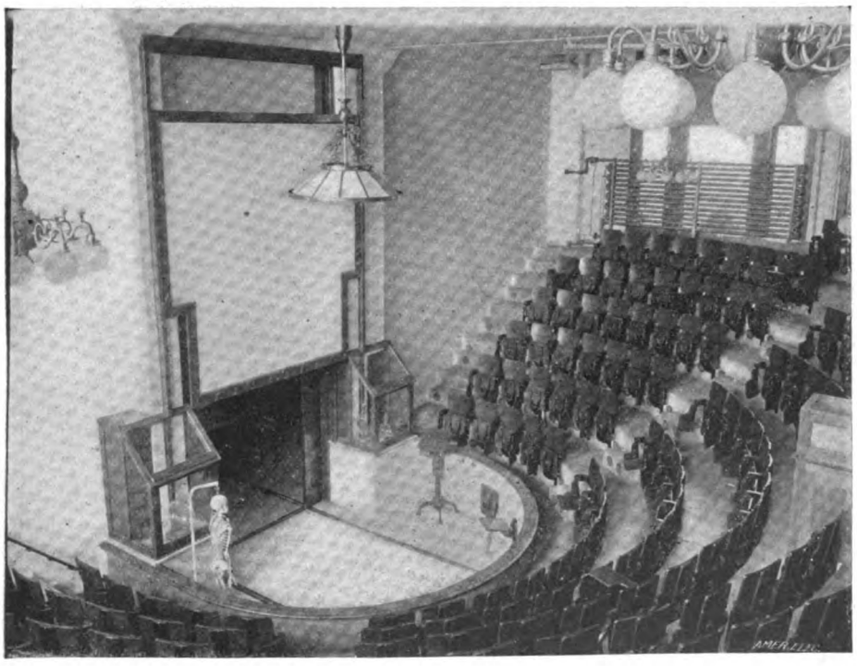


FIG. 3.—OPERATING AMPHITHEATRE.

furnished by the Ward & Upright Engineering Company of Brooklyn.

After passing through the filter the water enters a Berryman heater which receives the exhausts of the engines, and its temperature is thereby raised nearly to the boiling point. Two feed pumps are supplied, either of which can easily feed both

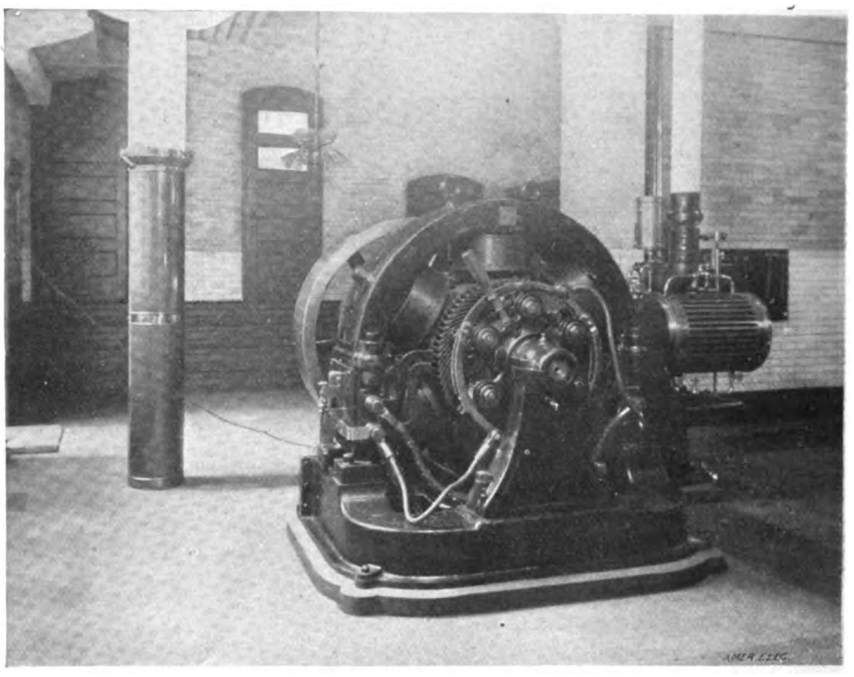


FIG. 2.—ONE OF THE GENERATORS.

boilers. Besides these feed pumps there are two compound elevator pumps, a pump for fire and house purposes, two pumps to return water from heating stacks to the boiler, a pump to take care of the drips from traps, etc. The latter three and the feed pumps are governed by Kieley pump governors. A moving injector is also provided, and in this way the boiler may be fed from five different sources, which practically renders a break-down of the feeding system impossible.

A feature of this plant is the great economy which has been effected in saving heat and hot water. The returns from the steam heating system are taken care of by the pump governor already mentioned. A refrigerator system which uses heating coils for evaporating the ammonia, disposes of its condensation in two ways; a portion of it is used for making ice, and as it is distilled water very pure ice can be manufactured therefrom—in fact, the very action of freezing tending to remove foreign substances of all kinds. The remainder of the condensation from the refrigerator heating coils is delivered to the pump governor and returned to the boilers. Even the heat in the blow-off tank is largely abstracted before its contents are permitted to run into the sewer. The building must be supplied with very hot water, for it is very necessary in surgical work, and the blow-off tank contains a system of coils through which water is passed and thereby heated for this purpose. So effective is this device that an automatically controlled heater which was installed for the purpose of heating this water and which employs live steam, is never used. This arrangement has the further advantage that it reduces the temperature of the waste drips to such a degree that they may be safely pumped into the sewer. Without this arrangement it would be necessary to use cold water from the meters to pass through the coils in the drip tank in order to reduce the temperature of the waste sufficiently to comply with the law.

The refrigerator system is provided with a condenser which uses a considerable volume of water from the city service. A tank is provided for the accumulation of this condenser water and fitted with ball cocks to supply it without overflow when the re-

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frigerator is not running. This tank is connected with the house pumps which supply the tank on the roof, and also with the feed pumps, by means of which its contents can

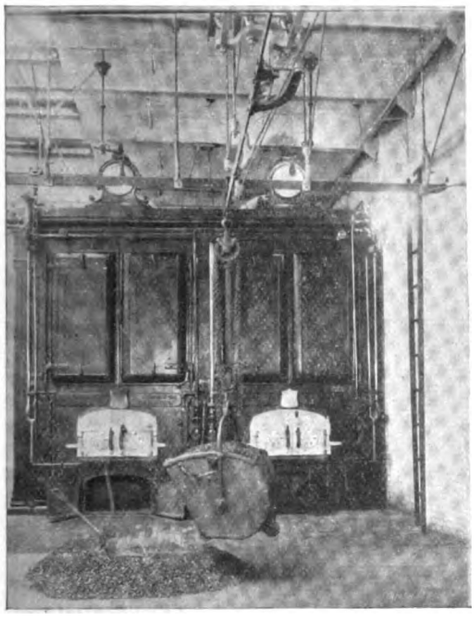


FIG. 4.—FIRE-ROOM, SHOWING COAL CONVEYOR.

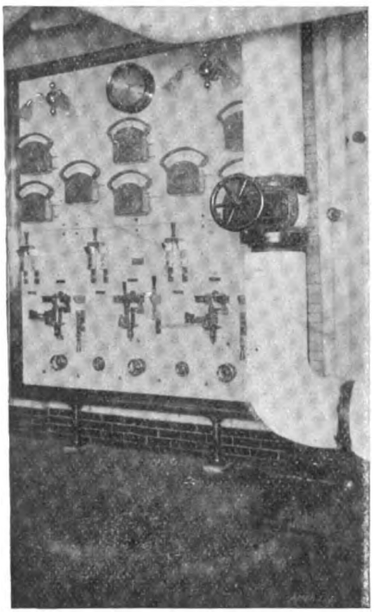


FIG. 5.—SWITCHBOARD.

be fed to the boiler if that is desirable. These economies are very effective and materially reduce the cost of operation.

The boilers generate an excellent quality of steam which they deliver to a 10-in. header. This header is fitted with appropriate valves which are in many cases in duplicate and with a 4-in. bypass. The valves are all Jenkins' make with the exception of the back pressure valve and the reducing valve, which are of the Kieley type. The system is thoroughly drained at every pocket by Kieley traps and no separators are necessary. The steam pipe system is covered with asbestos, which has been put on with great neatness. The general effect is very pleasing, and once a week, or as often as may be necessary, all discolored spots are painted with James Clark's special preparation.

The steam is delivered to three small Ball & Wood engines. These engines have cylinder dimensions of 13 x 12 ins., a speed of 275 r.p.m., and develop 90 h.p. at 100 lbs. of steam. They are equipped with the new Rites governor, which has been recently improved by the Ball & Wood Company. The moving parts are inclosed in such a way as to effectually prevent danger or damage and to readily permit inspection of bearings and slides.

The performance of these engines is highly satisfactory. They run almost noiselessly, the only sound that can be heard being that of the steam passing through the ports, while the absence of all vibration can be effectually demonstrated by the old-time test of balancing a nickel on the valve chest. This performance is partly due to the excellent foundations, which are 14 ft. deep.

The engines exhaust into a long header which passes up through the flooring and, returning above the engines, enters one side of a Berryman heater of appropriate capacity. The riser to the upper system of exhaust piping resembles a supporting pillar of the structure, and appears at the left in a picture of one of the units. Fig. 3 gives a general view of the engine room.

The heater into which the engines exhaust is connected in a unique manner. The engines do not exhaust through the heater but into it, for the other side or outlet is closed. Thus the heater is connected like a condenser and the condensation which accumulates in the bottom is pumped into the drip tank. In spite of this unusual method of connection, it remains to be said that the heater most efficiently accomplishes its purpose of heating the feed water to a high temperature.

Back pressure valves are provided on the exhaust system, which enable the engines to exhaust into the atmosphere if the back pressure should exceed a certain amount, and this amount is fixed at from 2 to 4 lbs., according to the state of the weather.

Besides the heater, the exhaust of the engines also enters the steam radiator system of the building. This system is arranged on the double pipe plan and consists of three parts, the direct, the indirect and the direct-indirect methods of heating being practiced. The direct-indirect system is used in corner rooms, where the dust from the blast wheels could not very well be carried; the air in this case is taken from the outside through registers in the walls.

Double pipe radiators distributed throughout the building and provided with automatically controlled valves, comprise the direct system. The indirect system consists of 7000 ft. of pipe, which is constructed into an appropriate radiator, and installed in a chamber through which air is forced into the ventilating ducts. Both of these radiator systems drain to the pump governor, as before mentioned.

The lubricating system of the plant is very complete and effective. Two large cylinder lubricators are provided, and either one is capable of lubricating all of the cylinders in the entire plant. These lubricators are piped to the various cylinders, and at each of them the oil passes through a suitable sight-feed indicator, delivering oil to the entering steam pipes. The indicators are each provided with a little wire passing through the cylinder of the tube, which serves to guide the bubble of oil straight upward and prevent its fouling against the sides.

A central distribution of oil in this way is much to be desired, for in the first place it requires less care than a multiplicity of small lubricators, and in the second place less oil is wasted, for as is well known, ordinary lubricators are filled to overflowing and the surplus oil is wiped off with a piece of waste, both of which are undesirable in a station.

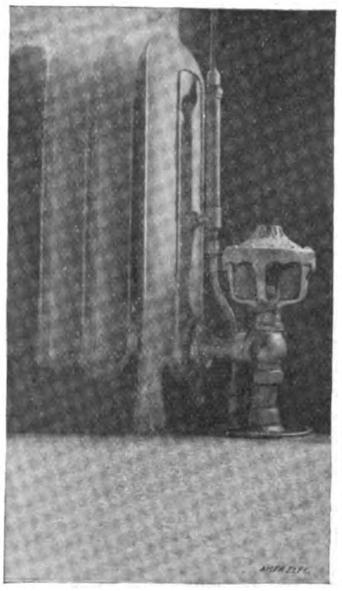


FIG. 6.—THERMOSTATIC VALVE FOR RADIATOR.

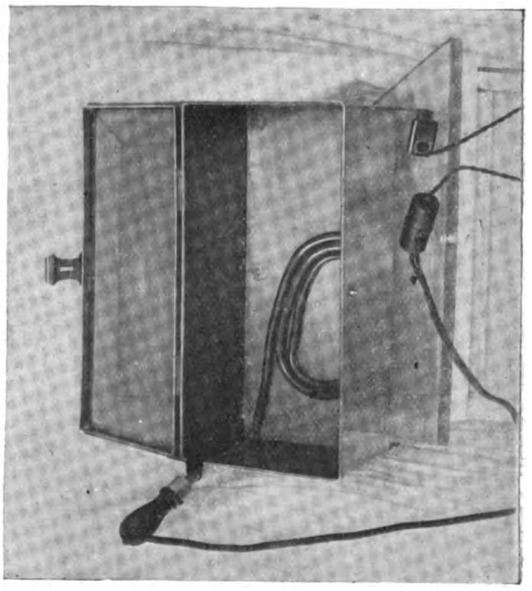


FIG. 7.—HEATING COIL FOR STERILIZER.

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The engine lubricators are supplemented with a small cylinder lubricator, which may be operated in case both of the large lubricators should fail, and they are also provided with a hand oil pump which serves the double purpose of an additional reserve and as a means of injecting Dixon's graphite into the cylinders. The management are great believers in this material as a cylinder lubricator and supply it to all of their high-speed pistons.

The lubricating system of the high speed bearings, which require a thin oil, is also centralized and consists of a purifier and two reservoirs. The oil is forced from the reservoir to the engine bearings by means of compressed air, and is delivered in a steady stream on each bearing. It is drained from the ends of the bearing by appropriate troughs and passes back to the purifier, by means of which it is thoroughly cleansed and returned to the reservoirs once more. The two reservoirs are used alternately, as it is believed that the oil improves on standing for a period. Compressed air has been found vastly superior to water pressure as a means of forcing oil to the bearings. Water is likely to contain ingredients which might cause the oil to saponify, and in addition, means must be provided for periodically removing the accumulated liquid. Connections, however, are made to use the water pressure in case the compressed air system should fail.

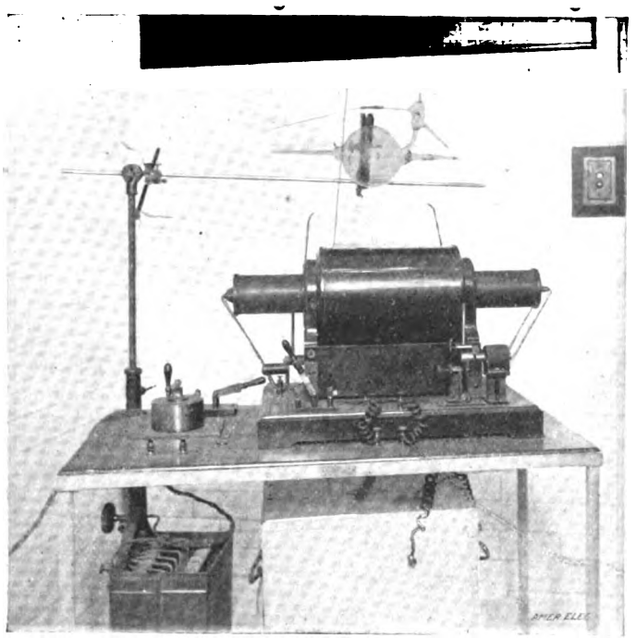


FIG. 8.—RONTGEN RAY OUTFIT.

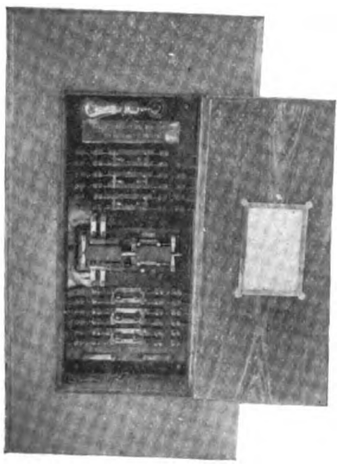


FIG. 9.—CAUTERY TRANSFORMERS.

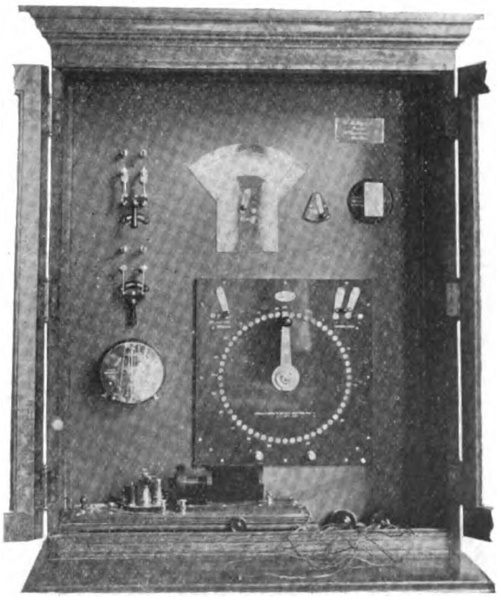


FIG. 10.—ELECTROTHERAPEUTIC CABINET.

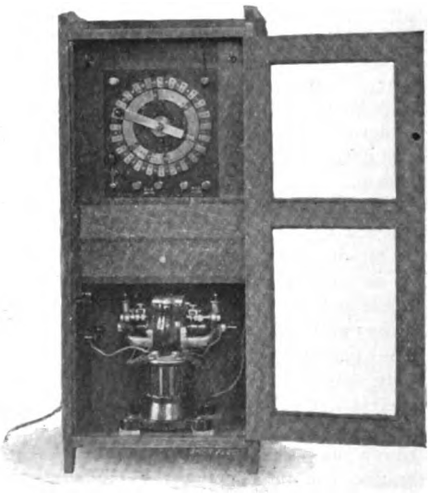


FIG. 11.—DISTRIBUTING CABINET.

The compressed air system is a feature of the plant and is worthy of special description. A small pressure tank is provided, which is kept at 15 lbs. by a little double cylinder pump. When the pressure drops below this figure, a little piston in a suitable cylinder is forced inward by means of a spring and thereby actuates a small valve which admits compressed air to the various automatic valves necessary to control the pump, which immediately starts up and quickly raises the pressure to the required amount, when the little piston is forced out, turning air on the diaphragms and the valves promptly close.

This compressed air is used for operating the automatic valves of the radiators, which are controlled by thermostats. All of the automatic valves of this class are of the Johnson make. In addition, compressed air is also used for the oil reservoirs as already indicated, and for the embalming of dead bodies, which are frequently received at the Clinic for scientific purposes. The embalming fluid is placed in a two-necked bottle, the delivery tube of which is sufficiently long to reach to the bottom thereof. Compressed air is forced into a tube, which is tightly sealed into the other neck of the bottle, which forces the embalming fluid out and injects it by means of suitable connections into the veins and arteries of the body to be embalmed.

The radiators and the thermostats controlling them are interesting and are shown in Figs. 6 and 15. The thermostat consists of a little arm made of two strips of brass and steel sweated together. This arm is bent into a U shape, and under the influence of lower temperature, tends to bend still more by reason of the unequal contraction of its component metals. In the act of bending it presses a little leaden cap over a minute orifice and thereby permits compressed air on the backs of diaphragms of steam and return valves to escape, a spring under the diaphragm then opening the valve controlling the radiator. Should the temperature change a sufficient amount, the leaden cap opens the minute orifice in the thermostat, the operations are reversed, the radiator valves are closed. A little screw at the base of the thermostat enables

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its adjustment for a considerable range of temperature.

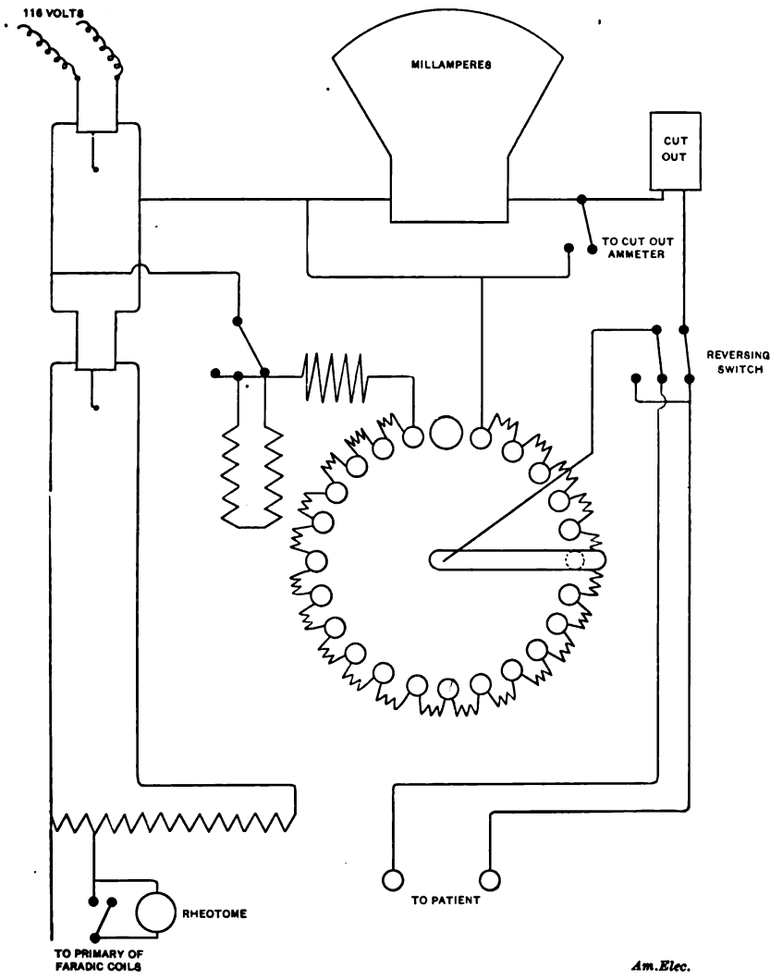



FIG. 12.—DIAGRAM OF MEDICAL SWITCHBOARD.

The source of electrical power in this building consists of three Western Electric dynamos. These machines, which are of 50-k.w. capacity are provided with 6 poles and directly connected to the Ball & Wood engines. They are arranged to operate in multiple and for this purpose are provided with equalizer connections, the equalizing switches being on the machines. They deliver their current to a switchboard, furnished by the Western Electric Company, on which are placed suitable instruments and switches for measuring and controlling the output. Each machine is provided with a main switch, a circuit-breaker, ammeter, voltmeter, and ground-detector, with switch to each machine, bus bar and to ground. A differential voltmeter is also provided and is found very convenient. All of the instruments are of the Weston illuminated dial type. An illustration of the switchboard is given in Fig. 5.

The system of wiring is on what is known as the cabinet plan. Each floor is provided with risers which pass to a cabinet which becomes the center of distribution. These cabinets are well designed and are of excellent workmanship. Each circuit is provided with a baby knife switch and fuse.

One of the cabinets is shown in Fig. 11. It is lined with slate, which is painted and grained to resemble woodwork. On the door of the cabinet is placed a panel containing a typewritten sheet explaining the various circuits that the switches control. To facilitate the explanation, the switches are all numbered.

A feature of interest in the cabinet shown is the automatic switch which appears in the center of the panel. This consists of a double solenoid which acts on an iron core. When the core is in one side of the solenoid, it completes the circuit for the other half. The plunger is attached by a suitable system of levers to a double pole knife-switch, which it is thus enabled to operate. The chandelier which this switch controls is located in the lecture room, and at a suitable point two buttons are provided, one in each solenoid circuit. Thus controlled, the plunger can be made to move to the right or to the left and close or open the switch as desired. There is also another point where two controlling buttons are installed, and there could easily be as many as might be desired. The chandelier and similar lights are controlled by means of Cutter flush switches in addition to their control at the distribution box. The building is wired throughout in iron armored interior conduit. There are many plug sockets in the building which are of the flush type.

The ventilating system of this building is very complete, and it is interesting, for electricity plays an important part in its operation. A large space in the basement is set apart for a ventilating chamber. Into this the air enters and is drawn through screens by two large engine-driven Sturtevant fans, 7 ft. in diameter. They force the air into a large chamber into which is placed the heating coils before mentioned, and from thence air is distributed by suitable ducts into every room in the building. The exit of the air is provided for by another system of ducts, and on the roof of the building are installed three large electric motors, two of which drive fans for the purpose of drawing the air out of the building and are connected to these exit ducts. The third fan is 54 ins. in diameter, driven by a 7½ h.p. motor, and employed for forcing air into the dissecting room through automatically controlled heating stacks. The air is drawn out of this room by the same system of ducts that serve to remove the air from other parts of the building. The dissecting room, from the nature of the operations carried on there, requires special ventilation and the

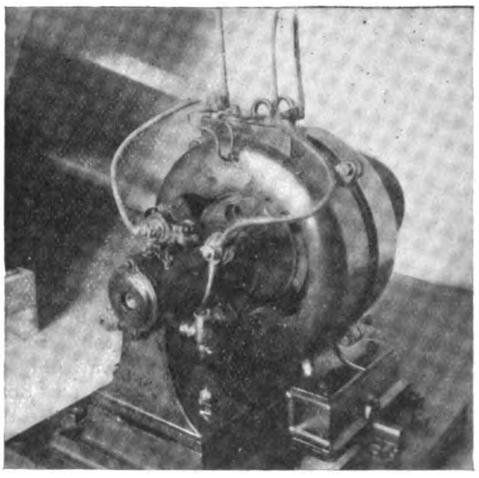


FIG. 13.—VENTILATING MOTOR.



FIG. 14.—CAUTERY TRANSFORMER.

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air is changed in this department very frequently.

In Fig. 13 is shown a view of the Lundell motor, which is typical of those used for driving the fans in the upper part of the building. The two fan motors which are used in forcing the air out of the building are of 20 and 30 h.p., respectively.

The applications of electricity to surgery and medicine, though very diverse as far as the actual methods of treatment are concerned, do not employ such a large variety of apparatus as has been supposed. For the direct application of electricity to the human system a combination board is provided. On this board are arranged a main switch, a milli-ammeter and an adjustable resistance through which current from the lighting circuit is passed. This resistance is tapped off to many points arranged in a circle on the switchboard and over these points swings a contact arm. One electrode is connected to one terminal of this resistance, and the other to the contact arm. As the latter is swung over its points, the potential between the electrodes rises. By throwing in additional resistance in series, the current in the main circuit is reduced, and the difference of potential between sections thereon is correspondingly reduced. In this way the patient can be submitted to from zero to thirty volts in steps of one volt, and from thirty to eighty-five volts in steps of two volts. The milli-ammeter is connected in series with the patient and the current that is used can thus be determined. The instrument has two scales, one reading 50 milli-amperes and the other 500 milli-amperes. There is also in series with the patient an automatic cut-out which can be set to break the circuit should the current by any accident reach a dangerous value.

A faradic coil of the Dubois-Raymond type is employed. Two secondaries are provided for this instrument, one of fine and one of coarse wire, and the intensity of shock is regulated by varying the position of this coil with reference to the primary winding, a rack serving to drive the secondary coil back and forth over the core. There are two circuit breakers, each of which has certain advantages. One of these is for low frequencies, and is built on the metronome plan. The circuit is broken by means of a clock-driven pendulum with an adjustable bobbin, and can give interruptions from 6 to 600 per minute. More rapid interruptions are provided by means of an ordinary vibrator. The contact of this vibrator is mounted on a swinging arm, which can be moved so that its position relatively to the point where the spring of the vibrator is fastened varies. In this way a considerable range in the rapidity of interruption can be obtained, and the circuit-breaking devices enable the use of any frequency within wide limits. A photograph of this board is shown in Fig. 10, and a diagram of the connections appear in Fig. 12, and from them the method of operation of the apparatus can be easily understood.

Another interesting adaptation of electricity to surgical uses are the cautery instruments. These consist of a rotary and a static transformer. The rotary transformer takes current at 118 volts, and from two collecting rings which are tapped into the armature winding at equally distant points, it delivers alternating current to a static transformer, the secondary coil of which is adjustable. Taps lead from various points of the secondary winding to a series of contacts arranged in a circle, and an arm swinging over this contact varies the amount of secondary in circuit. The range of pressure obtainable is from zero to 8 volts in 48 steps, and the quantity of current is sufficient to heat the largest part of the electrodes to full working temperature. This current may also be used for lighting miniature incandescent lamps for dental and surgical purposes.

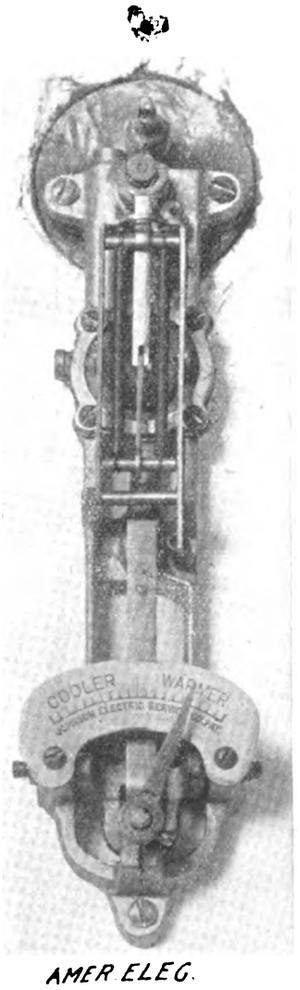



FIG. 15—THERMOSTAT.

There are four equipments at the Clinic, which have different types of transformers. One of these complete is shown in Fig. 9, and the other is shown in Fig. 14. Both of these transformers were made by the Holtzer & Cabot Electrical Company. The ironclad machine shown in Fig. 14 has in addition an extension on its shaft to which may be coupled drills and other appliances for cutting bone. The machines are capable of delivering 1/6 h.p., either in mechanical power for the bone-drilling devices, or alternating current for the static transformer as may be desired.

The Clinic is provided with an excellent Röntgen ray equipment which is shown in Fig. 8. It consists of a Queen induction coil which is capable of striking fully 10 ins., a large condenser for minimizing the spark at the circuit-breaker, a fluoroscope and a supply of tubes. The tube shown in the photograph is of the self-regulating type, and is said to maintain a very constant degree of vacuum. The current is supplied to the apparatus from the lighting circuit, across the terminals of which a resistance is connected. The coil is connected across a suitable section of this resistance, and in this way receives the necessary low voltage. The condenser used with this coil is of very large capacity, and when charged at full dynamo pressure, contains enough electricity to run the vibrator for an appreciable period of time and discharge several sparks across the terminals of the secondary.

Electric lights are largely used in the building for illuminating devices for examining the eye, and electric lamps are used for the laryngoscope and similar devices for examining the mouth and throat. About 1000 incandescent lamps and 26 enclosed arc are installed in the Clinic and in the laboratories, lecture-rooms, etc., of the teaching department of the endowment.

It may be safely said that this building is one of the best of its kind in the world. Every pains has been taken to render it so, and money has not been spared. The corners of the wainscoating and the walls are rounded to prevent the accumulation of dirt and dust. The doors are built up without panels and present a perfectly smooth surface without trimming or moulding of any kind, and are veneered with ¼ in. solid oak. Everywhere in the various departments the flooring is of tile or mosaic, the walls are of enameled brick and the furniture of glass-enameled iron or the smoothest quartered oak. It is a most discouraging structure for a microbe in which to find lodgement, and it is very easy to keep clean.

The design and execution of the electrical and mechanical equipment of this building is largely due to the present superintendent, Mr. J. G. Ould, who has since its inception exercised the most scrupulous care and attention in its construction, operation and maintenance.

## American Electrical Market Abroad.

The United States Consul at Brussels reports that the electric lamps, as well as nearly all other electrical supplies used in Brussels, are principally of German origin, Holland supplying a few, and England a fair percentage of the electrical wires employed. American lamps and other electrical goods are exposed for sale on this market, and are conceded to be superior to those imported from Germany, France and England. The Consul believes that with proper effort the trade in this line could be greatly increased, especially in copper wire, insulated wire, large cables and arc lamps.

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# Induction Motors.

## POLYPHASE AND SINGLE-PHASE ALTERNATING CURRENT INDUCTION MOTORS.

BY ERNST JULIUS BERG.

In the first part of this article was discussed the construction of synchronous motors, their similarity in general constants and appearance to ordinary alternating current generators, and the necessary field adjustment to operate them at various power factors; their use as phase controllers, that is, for compensating for lagging currents incidental to other loads; their use to obtain a constant potential point in any part of the distribution, and, finally, the conditions which govern their starting torque.

### POLYPHASE INDUCTION MOTORS.

The greater number of this type of motors are also of the polyphase type; although a great many more single-phase induction motors are installed than single-phase synchronous motors.

The characteristic features of induction motors compared with synchronous motors are that they are self-contained units; that is, they do not require any exciters, and they start with considerable torque—in fact, can be made to start with any torque. Although they do not run at exact synchronous speed with the generator, their speed is nevertheless practically synchronous. It can, however, be varied, yet they are not well suited for efficient operation at the variable speeds. They will operate with as high efficiency as synchronous motors and direct current motors, but necessarily have a lower power factor, thus introducing lagging currents into the system on which they are run. Their overload capacity is, as a rule, large, although not so large as that of synchronous motors.

Regarding their mechanical construction, one part, the primary, has a winding similar to that of the direct-current machine. The secondary winding, however, is often extremely simple, consisting in one type of motors simply of copper bars projecting through the iron laminations without any insulation whatever, and connected together by copper rings at each end.

They are built on essentially two different lines— one type with regular winding on primary and secondary, the other with regular winding on the primary and squirrel cage winding on the secondary. Depending upon the use intended for the motor, one construction or the other is preferable. Indeed, the starting conditions of the motor in almost every case decide the type.

Motors with definite winding on primary and secondary can be made very efficient and still start with any desired torque and with reasonably small starting current, by the use of a resistance in the secondary. Motors with squirrel cage armature can be made to start with considerable torque, but are then necessarily less efficient, or take in starting a larger current.

The first type of motors may be recommended and used wherever considerable starting torque is desired, and where the current taken by the motor must be limited. The second type has the advantage of greater simplicity, and may be used where less starting torque is necessary, and then in connection with the compensator, so that the motor is started at a reduced voltage, and therefore with a reasonable current.

In places where motors have to operate in damp atmosphere, and, in general, in places where they are exposed to considerable hard usage and subject to little care, the squirrel cage type should be used, even if the starting torque has to be large.

The characteristics of a polyphase induction motor are essentially those of a direct-current shunt motor; that is, it is an approximately constant speed motor. Speed

TABLE I.—CONSTANTS AT VARIOUS SPEEDS.

| | Eff. | P. F. | App. Eff. | Torque App. Eff. |
|---|---|---|---|---|
| At rest..... | 0. | 90 | 0 | 80 |
| ¼ speed.... | 22.2 | 90 | 20 | 80 |
| ½ " .... | 44.5 | 90 | 40 | 80 |
| Full speed.. | 89 | 90 | 80 | 80 |

control can be obtained by varying the secondary resistance or the impressed electromotive force, or by changing the connections of the field winding whereby the motor speed is reduced or increased by reducing or increasing the number of poles.

The first method, that of varying the resistance of the secondary, is the most efficient, but necessitates the use of a specially wound secondary.

The efficiency is proportional to the speed, and the power factor is constant at all speeds, so that, for instance, a motor with 89 per cent efficiency and 90 per cent power factor at full load would have the constants at rest, one-quarter, one-half and full speed, which are given in Table I. The current is proportional to the torque.

The second method, that of changing the speed by means of impressed voltage, can only be made as good at one particular speed, and is always very much inferior at others. Depending upon the shape of the torque curve, the efficiency and power factor of such a motor changes over a wide range.

It is always advisable to make the sec-

TABLE II.

| | Eff. | P. F. | App. Eff. | Torque App. Eff. |
|---|---|---|---|---|
| At rest..... | 0. | 48 | 0. | 23 |
| ¼ speed.... | 10.5 | 50 | 19.5 | 29 |
| ½ " .... | 32.5 | 60 | 19.5 | 39 |
| Full " .... | 87. | 90 | 78.5 | 78.5 |

ondary of comparatively high resistance and of lowest possible reactance; therefore, if the motor above mentioned were built for compensator control—that is, speed control by change of impressed voltage—the efficiency would probably not be more than 87 per cent to give the best all around conditions.

Assume, furthermore, that the motor is built for a maximum of 50 per cent more starting torque than rated torque at rated voltage, it would have the constants given in Table II. The power factor is practically the same at the same speed, regardless of impressed voltage.

In Table II. the heads of the several columns have the following definitions:

$$\text{Efficiency in this table} = \frac{\text{Mechanical Output}}{\text{Electrical Input in Watts}}.$$

$$\text{Power Factor} = \frac{\text{Electrical Input in Watts}}{\text{Electrical Input in Volt-Amperes}}.$$

$$\text{Apparent Efficiency} = \frac{\text{Mechanical Output}}{\text{Electrical Input in Volt-Amperes}}.$$

$$\text{Torque Apparent Efficiency} = \frac{\text{Power at Synchronous Speed for Given Torque.}}{\text{Electrical Input in Volt-Amperes}}.$$

The third method, that of changing the number of poles, even disregarding the feature of a complicated mechanical construction, would not permit of a gradual change of speed. For instance, by changing the number of poles from six to four, the speed of a 60-cycle motor would be changed from 1200 to 1800 revolutions, which is rather a large step.

The constants of such motor at its possible speeds would, however, be better than that of the compensator controlled motor; in fact, the efficiency would even be better than the rheostatic controlled motor. The power factor, however, is necessarily very much lower, so that the torque per ampere—that is the apparent torque efficiency—is about the same.

In discussing the starting conditions of induction motors, it was stated that in order to get a reasonable efficiency the armature resistance has to be low. In general, the lower the resistance in the primary and secondary, the higher is the efficiency and the less the drop in speed; also, though to a small extent, the larger the output for a given impressed voltage.

The slip of the induction motor—that is, the drop in the speed—is directly dependent upon the armature resistance. For a given load by doubling the armature resistance the slip will be twice as great, etc. By varying the primary resistance the speed is not changed, but the heating is increased and the output of the motor decreased.

The self-induction of the motor is of greatest importance. By using very few and large slots in the primary and secondary, the self-induction is decidedly higher than by subdividing the winding in many slots; consequently, wherever low self-induction is necessary, the primary and secondary are wound with a great number of coils in different slots.

The power factor of the motor depends upon the self-induction and magnetizing current. The relative effect of self-induction and magnetizing current on the power factor of a motor is such that at light load or up to three-quarters and full load, the magnetizing current is more predominant, while at full load and particularly at overloads, the self-induction is predominating.

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In motors operated on low-frequency circuits, such as 25-cycle, the self-induction with distributed winding is extremely low, so that the power factor at full load and even some overload, is practically entirely determined by the amount of magnetizing current; and since this magnetizing current is almost proportional to the lengths of air gap, it is possible to obtain motors of extremely high power factors by making very small air gaps. It is rather a delicate point to decide where to limit the lengths of gap. One manufacturer, for instance, may consider it better to have a motor of 95 per cent power factor and 1/16 in. clearance, and another consider that a motor of 90 per cent power factor and double as long an air pay would be preferable. As a rule, it is well worth while to consider the question of mechanical clearance, and rather sacrifice power factor a little to get a motor which will need less attention as to the bearings.

Should the power factor of a motor with large clearance be 2 or 3 per cent lower, it means only that the current taken by the motor for the same load is 2 or 3 per cent larger, which, in most cases, is not objectionable, because it does not represent more power from the generator or more coal from the coal pile. It simply consists of "wattless" current.

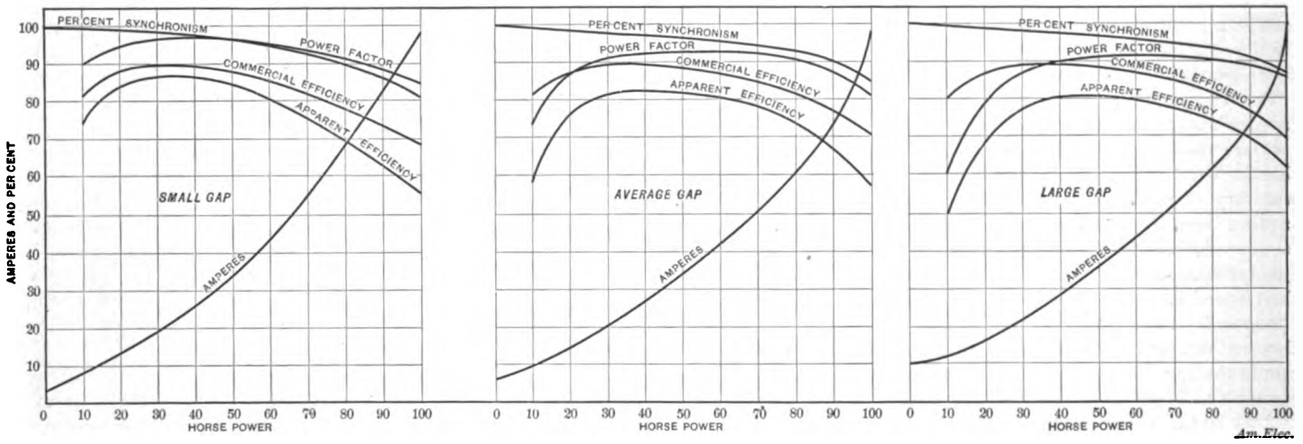
To illustrate the dependence of power factor on lengths on air gap, in Figs. 1, 2 and 3 are plotted three characteristic curves of the same induction motor, a 40-h.p. 25-cycle being chosen. The constants with normal air gap are shown in Fig. 2, the constants with one-half of this air gap in Fig. 1, and with 50 per cent larger than normal air gap, in Fig. 3. As is readily seen, the efficiency is not much changed by this modification in air gap. It is but ½ per cent higher at full load in the two motors with smaller air gap, than in that with the largest gap. The power factor, however, is greatly different. With the shortest air gap, the power factor is 97 per cent, with the average gap it is 92½ per cent, and with the longest gap, 90 per cent. The maximum output is not affected.

The apparent efficiency, which is directly noticeable in the current input for a given output, is proportional to the power factor. As a rule, motors with large magnetizing current give a large margin in output. This is not on account of the large magnetizing current itself, but is caused by the low self-induction incidental to the large magnetizing current and the lesser number of turns.

Two different types of induction motors are built, one of which has high light load constants and a maximum output of approximately 50 per cent more than rated output; the other has lower light load constants, but gives a large margin in output—from two to four times the rated output before stopping.

TABLE III.—CONSTANTS OF 10-H. P. 60-CYCLE MOTORS

| | Load. | A | B |
|---|---|---|---|
| Efficiency ..... | ¼ | 74 | 69 |
| | ½ | 85.5 | 80.5 |
| | ¾ | 88 | 84.5 |
| | Full | 86 | 86 |
| | 1¼ | 82 | 86 |
| Power factor... | ¼ | 61 | 50 |
| | ½ | 76 | 71 |
| | ¾ | 81.5 | 80.5 |
| | Full | 83 | 85 |
| | 1¼ | 82 | 87.5 |
| App. Eff..... | ¼ | 45 | 34.5 |
| | ½ | 65 | 57 |
| | ¾ | 71.5 | 68 |
| | Full | 71.5 | 73 |
| | 1¼ | 67 | 76 |




FIGS. 1, 2 AND 3.—CHARACTERISTIC CURVES, 40-H.P. MOTOR.

The advantages of the latter type of motors are apparent in circuits with greatly varying voltage, since the torque of a motor is proportional to the square of the impressed voltage; therefore, if, for instance, the voltage for some reason or other drops 20 per cent, a motor of the first type would be liable to stop, whereas one of the other type would still have a margin of from 50 per cent to 100 per cent of rated output.

To illustrate the constants of the two types of motors, the characteristic curves of two 10-h.p. 60-cycle motors running at 1200 r.p.m. are given. Column A represents the first type and Column B the second type.

### SINGLE-PHASE INDUCTION MOTORS.

These motors are essentially identical with polyphase motors in their mechanical construction and characteristics. While running, they give the same characteristics as polyphase motors, but have slightly lower efficiencies and power factors, which, however, can be greatly improved upon by the use of condensers connected across one of the windings.

Electrically, however, the single-phase induction motors run under quite different conditions than polyphase motors. For instance, a polyphase motor running light has no current in the secondary, and consequently no loss in the secondary winding, whereas a single-phase motor, even when running light, has considerable current in the secondary—approximately half that of the primary current.

The speed regulation of a single-phase motor is better than that of the polyphase motor; for example, the drop in speed of a certain motor run on a single-phase circuit is half of that when operated on a polyphase circuit at the same output.

The rating of a single-phase motor for the same heating is less than a polyphase motor. Roughly speaking, they can be given a capacity corresponding to about 70 per cent of the three-phase capacity and are then operated at about 30 per cent higher voltage, provided the same winding is used; or, which is equivalent if a certain motor is designed for multiphase work and for single-phase work at the same voltage, the multiphase rating is about 40 per cent higher than the single-phase rating, and the multiphase winding has about 30 per cent more turns in series than the single-phase winding.

They are mostly used in connection with some starting device, generally consisting of a reactance in series with a non-inductive resistance, some times of a condenser, and some times of a combination of the two. They can be made to start with practically any desired torque, but take in starting 50 to 100 per cent more current than multiphase motors for the same torque—that is, if no condensers are used. By the use of condensers the starting current can be reduced and good torque can be obtained with very reasonable currents. The condensers may conveniently be left in circuit all the time, since they will act as a compensator for the lagging currents and thus reduce the input to the motor for given output and raise the power factor and apparent efficiency. Since the condensers are inserted in a separate circuit and the charging current supplied therefrom, the wave shape of the generator is immaterial.

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## CONSUMPTION OF STEAM BY WARSHIP AUXILIARY MACHINERY—A FEW FIGURES.

BY F. W. ROLLER, M. E.

In a paper by Mr. W. D. Weaver, read recently before the New York Electrical Society, on the employment of electric motors for power purposes on war ships, mention was made of the gross inefficiency of the steam pumps and other auxiliaries that are at present there used. The actual extent of the waste occasioned in this way is realized by but few, and in connection with this point it is thought that some actual figures may be of interest.

The writer had occasion a short time since to make a careful investigation of the steam consumption of the auxiliary machinery in common use on the U. S. S. "Nashville," one of our modern gunboats. A distinguishing feature of this vessel is the very large amount of coal she carries in proportion to other vessels of her class, and by virtue of this fact, she is supposed to be capable of making very extended cruises or of remaining on port duty for great lengths of time.

To further this end her equipment comprises two different types of boilers, Scotch and Yarrow water tube, the former being of course the more economical and the latter furnishing the steam required for higher speeds and quick steaming with a minimum of bulk and weight. The main engines are quadruple expansion, with independently adjustable cut-offs and steam-jacketed cylinders designed for low steam consumption and with all details worked out for the same end. Her auxiliaries, consisting of two dynamo engines, two circulating pump engines, the steam anchor and boat winches, ash hoists, blower engines, work-shop engine, steering gear and numerous pumps, were in general of standard navy patterns and good representatives of their types, so that the results reached may also be taken as fairly representative.

The test was determined on because of the fact that it had been calculated in the design of the vessel that one of the Scotch boilers should be ample to run all of the auxiliaries and the evaporator under normal conditions, whereas experience showed that two were constantly required. The water that the boilers were called upon to furnish in port was, therefore, to be determined by test, the amount including only that called for by the group of constantly used machinery specified below and not for the total.

As the radiation losses in the auxiliary piping had also to be made up by the boilers, these were not deducted. Further, as the tests were not specially desired to be of more than ordinary accuracy, the cylinder diameters and strokes were measured only to the nearest sixteenth of an inch in figuring the horse power, and the indicator springs were checked only by substituting different ones of the same strengths in the same indicators and comparing the cards obtained under like conditions. The total steam consumed in each case was determined by running the apparatus for a sufficient length of time for the condensed exhaust to fill a large feed tank, the capacity of which was carefully determined by actual measurement and checked by calculation from its dimensions.

All the machinery had been overhauled and, with the exception of the larger of the two generating sets in which one of the two piston rings in one cylinder was broken, found in good order. The most interesting of the results found are given in the accompanying table:

| Apparatus. | I.H.P. | Steam per I. H. P. |
|---|---|---|
| Fwd. aux. feed pump (2 cylinders).. | 1.2 | 335 lbs. |
| Water service pump (2 cylinders).... | .67 | 348 " |
| Air and circ. pump eng. (1 cylinder). | 8 | 172 " |
| Small generating set (2 cylinders)... | 7.7 | 142 " |
| Large generating set (2 cylinders) .. | 14.9 | 96.6 " |

We had here then a total of 3679 lbs. of steam per hour to furnish less than 27.5 h.p. in nine different cylinders, which work was then transformed into light or directly applied by the apparatus.

The steam required by the evaporator, its combined pump and another small pump plus the boiler feed pump, added approximately another 5000 lbs. per hour for a good portion of the day.

From the enormous quantity of steam thus required the reason that a second boiler was needed under ordinary circumstances was at once made evident, and the object of the test, as far as this was concerned, attained. As the pistons and valves were all tight and properly set, and there were no piping leaks to be corrected, there remained nothing to be done, but the figures obtained certainly furnished food for reflection.

Let us make a short calculation of how we would have gotten along had there been an electric equipment instead of what was actually furnished. In the first place, the average amount of current required during the day to supply the lights in use and drive the electric ventilating sets and fans, was about 80 amps. at 80 volts or 8.6 e.h.p. The i.h.p. required to drive the pumps and engines above mentioned averaged, including everything, 5.3. This horse power may be figured from the known efficiency of small direct-current motors and the reducing gear through which they would drive, and allowing for the fact that they would be working much below their rated power, as no less than 10, and perhaps as high as 12 e.h.p. at the dynamo terminals.

Taking into consideration the fact that the boat winch, fire pumps or bilge pumps might be called on to run at any time, we would have to provide in our minimum capacity day unit for at least 15 e.h.p. additional, this amount being amply sufficient when we take into consideration the liberal safety margin allowed in all navy generating sets, and the ease with which they could carry 100 per cent overload till another unit or units could be started up and coupled in. Our total e.h.p., therefore, figures out as about 35, for which we would use a 25, or, as 24 is standard, a 24-kw. unit, which would ordinarily work at two-thirds load.

Allowing as high as 45 lbs. of steam per e.h.p. under these circumstances, a liberal figure considering that we would always be operating condensing, and that the machinery would be designed for a maximum economy at about this load, we have a total of 900 lbs. of steam called for per hour against 2339, or a saving of 1339 lbs. per hour. As the boilers were, as determined during the same test, evaporating about 9.5 lbs. of water per pound of coal, we have 141 lbs. of coal saved per hour, or 3384 per day. As our total daily consumption averaged about four tons, this 1½ tons saving means a clear 37.5 per cent from this cause alone.

This, however, is only one of the direct savings in coal consumption that would be effected. It will be noticed that the evaporator and distilling apparatus is charged with a very large proportion of the steam ordinarily consumed. Now of the fresh water supplied, that quantity required for cooking, drinking and washing purposes of course remains constant, but the make-up feed is decreased in nearly the same proportion that the steam drawn from the boilers is decreased under like conditions, and far more so where, as in this case, we reduce the total number of steam cylinders in operation. The amount of steam required for the evaporator is, therefore, again reduced and another source of saving in coal found.

See now what could be done if electrically-driven auxiliaries are used. In the first place, to provide for the space required for the extra generating units we should have to sacrifice some coal-bunker space. It happens that on the "Nashville" there were two bunkers, one of seventeen and the other of nineteen tons capacity, situated on either side of the passage connecting the forward and after fire rooms, either of which would make a splendid dynamo room. Say that the larger of these two was selected; we then have a total amount of coal carried of 381 tons instead of 400 tons as at present, but taking a case where a prolonged stay at a given port was to be made, and assuming that we start with full bunkers, it would take only fifty days to get down to 200 tons with the present machinery and consumption, whereas 72.4 days would be available with the electric equipment, a difference that would be nearly doubled were the coal on hand nearly exhausted before the bunkers were replenished. In addition, we would have the dynamos below the protective deck instead of above it as at present, a point of the greatest importance.

It is not the purpose to enlarge here on the numerous other advantages, such as flexibility, ease of repair, gain in weight and safety, temperature and so on, that would accrue from the use of electric power. These points have been gone over before in other places, but this matter of economy is alone most important. The data from which the consumptions under the proposed circumstances were figured was all taken from the daily performance of apparatus aperating under ordinary conditions and is in no way theoretical. The apparatus is likewise in no sense special, so that

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there would be no experimenting to do and no factors that could only be determined after extensive trials. Let us hope that the advantages so plainly offered will be taken advantage of.

## TYPES OF AMERICAN LIGHTNING ARRESTERS.

BY H. E. RAYMOND.

In types of lightning arresters the General Electric Company have followed lines different from those which most of the other concerns have chosen, and this difference lies in two distinct features. They do not pretend to prevent a rush of current in the direct-current devices, but make use of this momentary flow to cause its own destruction without injury to the dischargers and without the use of movable devices.

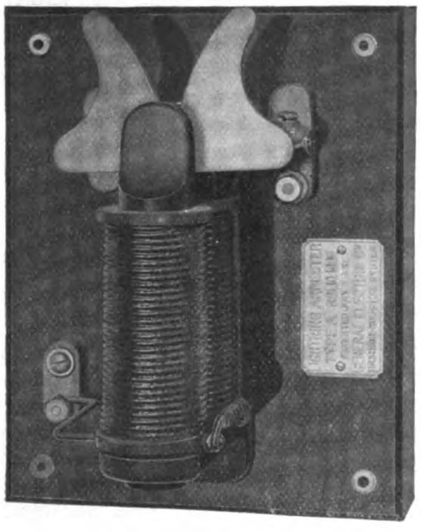


FIG. 1.—ARC ARRESTER FOR STATION USE.

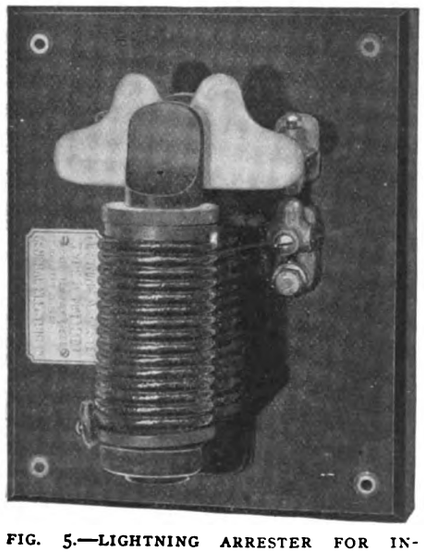


FIG. 5.—LIGHTNING ARRESTER FOR INCANDESCENT CIRCUITS.

The General Electric Company makes use generally of the Thomson method of arc suppression by means of a magnetic blow-out. This is based on the principle that a current flowing through any medium in a magnetic field in a direction crossing the lines of force is acted upon in a manner tending to move it in a direction approximately at right angles to the lines. It is precisely the same idea that is embodied in the rotation of a motor armature. The arc is simply current flowing through air and a metallic vapor of such high resistance that the arc, which is a visible indication of the $C^2R$, is a result. The arcing terminals and the poles of the magnet are placed at four quarters, and so arranged that the line of the arc will be at right angles to the lines of force in the section of greatest density. Where practical they are also so placed that the arc will be forced upward, the blow-out action being reinforced by the upward curvature caused by the current of hot air.

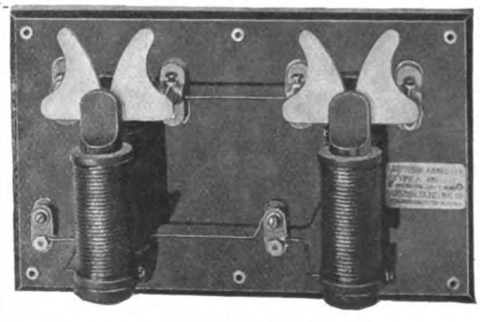


FIG. 2.—ARC CIRCUIT ARRESTER FOR HIGH VOLTAGE.

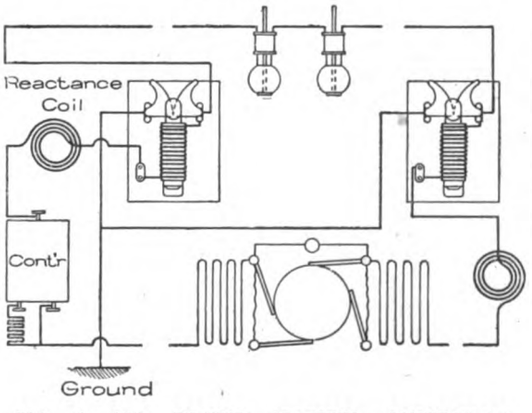



FIG. 4.—ARC CIRCUIT ARRESTER CONNECTIONS.

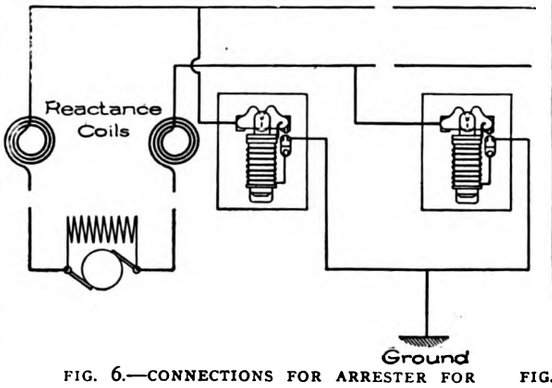



FIG. 6.—CONNECTIONS FOR ARRESTER FOR INCANDESCENT CIRCUITS.

Direct current lends itself with peculiar readiness to the use of this magnetic rupture, and the idea is involved in the design of all their arc breaking devices using direct current. On the other hand, the suppression of an alternating current arc is a problem of very different aspect. The voltages of this system at the present day are so much higher than in any other use of commercial electricity, and the inapplicability of alternating currents to the establishment of a strong magnetic field render it necessary to employ other methods of protection to the apparatus per se.

In order, therefore, to avoid the use of magnetic rupturing methods there is employed in their alternating current arresters a number of large metal dischargers in series with which is a resistance. The number of dischargers, with their adjacent gaps and the amount of ohms resistance, are proportioned to the voltage of the lines which they are to protect. The resistance cuts down the possible flow of current succeeding a discharge, and prevents an absolute short-circuit. This limited current is unable to heat the cylinders to the temperature necessary to the maintenance of an arc before the reversal of e.m.f. in the dynamo circuit brings the current to zero, at which point it ceases to jump the gap. The large mass of the metal, with its proportional radiating surface, dissipates the heat




FIG. 3.—ARC ARRESTER FOR LINE USE.




FIG. 7.—THE LIGHTNING ARRESTER FOR RAILWAY CIRCUITS.

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to such an extent that no amount or frequency of operation probable in practice is able to cause a sufficient temperature to render the "cooling effect" inoperative.

In both direct and alternating current apparatus their arc rupturing and preventing methods permit the use of a very small air gap. This is very essential, as the striking voltage of any arrester is to a very great extent dependent on the shortness of its gap space.

Fig. 1 represents the standard arc-circuit arrester for station use. This single form is adapted to circuits carrying a pressure not over 3750 volts, and is so designed that

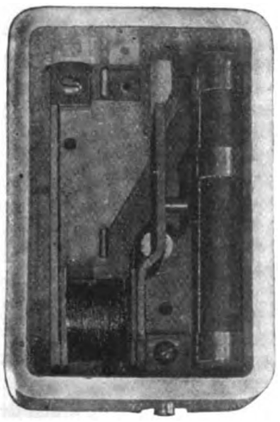


FIG. 8.—RAILWAY ARRESTER, SHOWING RESISTANCES AND MAGNETIC BLOW-OUT.

the current is all sent through the magnet coils, which are in series with the line. The small loss here is compensated by the permanence of the field during operation. The line is connected to the upper right hand terminal and the machine to the lower left hand. Any arc tending to hold across the discharge points its force in an upward direction by the field continually present. The divergence of these points and the upward curvature of the arc lengthens it to such a degree that the amount of current supplied by an arc machine cannot cause the generation of enough heat to hold it to the dischargers.

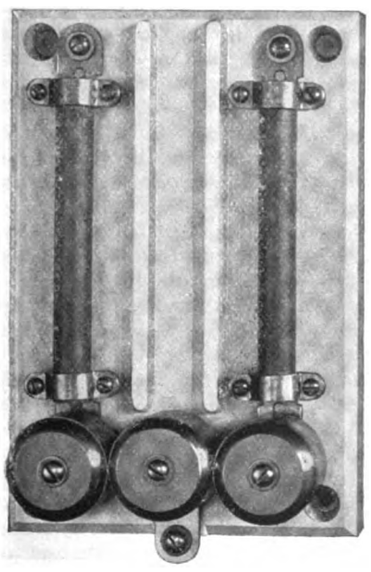


FIG. 12.—DOUBLE-POLE ALTERNATING ARRESTER FOR 1000 VOLTS.

For voltages higher than 3750 two arresters are arranged, so that their gaps and coils will be respectively in series, as in Fig. 2. The arc circuit arrester connections are shown in Fig. 4.

For incandescent service or direct-current up to 300 volts a series magnet would not be advisable, owing to the heavy currents, and in the arrester for such circuits. Fig. 5, the coils are in shunt with a small auxiliary gap in series with the main gap but so situated that it will not be affected by the field. The drop across this gap, should current arc cross it, forces enough current through the magnet coils to generate a strong field, which blows out the arc in the main gap. Connections for this type of lightning arrester are shown in Fig. 6.

For use of circuits of over 300 and up to 850 volts the type illustrated in Figs. 7, 8 and 9 was designed. The higher voltages, and possible heavy arcing, made it advisable in this arrester, as in the A. C. type, to use a low resistance to limit the possible flow of current. The principle

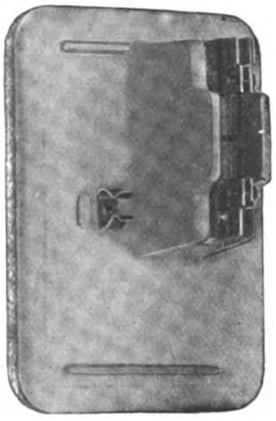


FIG. 9.—ARRESTER FOR RAILWAY CIRCUITS, SHOWING GAP.

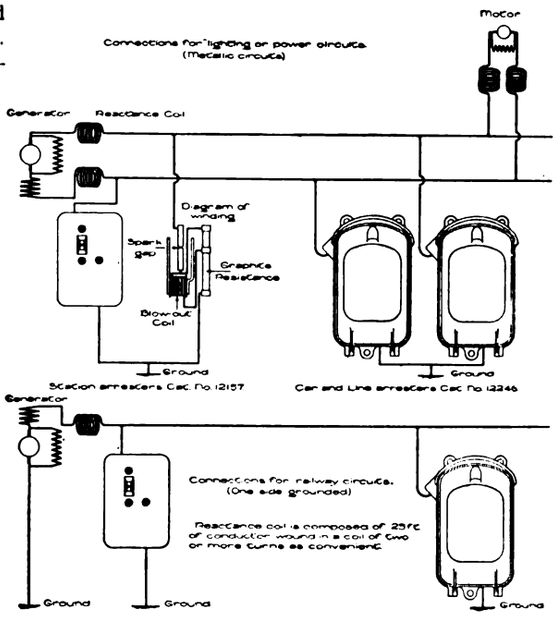



FIG. 11.—CONNECTIONS FOR MAGNETIC BLOW-OUT ARRESTERS FOR DIRECT CURRENT UP TO 850 VOLTS.

is the same, and the use of the resistance renders it possible to use a gap no larger in this form than in those for much lower voltages. For railway service this is especially important, owing to the dead grounding of one side.

As it would not be permissible to place the magnet coils in series with the gap, and not advisable to connect them in series with the line, it becomes necessary, in this type, as in the incandescent, to provide a drop across them without offering an inductive path to the discharge. This is obtained by placing them in parallel with part of the resistance. In Fig. 11 the connections are shown in general detail. It will be noted that choke coils are recommended. These should be placed in all circuits, *where but very little wire could otherwise be run between the arrester and the machinery protected.* The cut shows the uninclosed arrester for station use, and the type inclosed is an iron box for line and outdoor use.

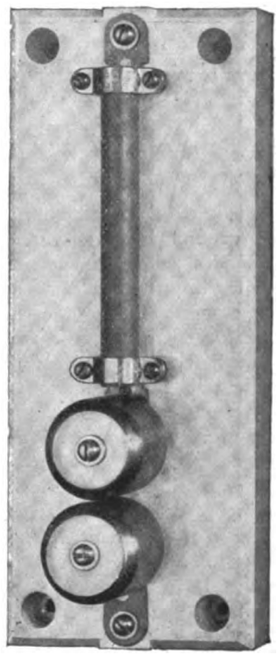


FIG. 10.—RAILWAY LINE ARRESTER FOR POLE USE.



FIG. 13.—SINGLE-POLE ALTERNATING ARRESTER FOR 1000 VOLTS.

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The double pole arrester for alternating circuits is shown in Fig. 12. The discharging cylinders are 2 ins. in diameter and 2 ins. in height, and are screwed to studs fastened rigidly to the base. The resistance, which is of graphite, is clearly non-inductive. The various forms, which are simply convenient modifications of the same idea, are illustrated in Figs. 13 and 14.

For voltages over 2000, the 2000-volt double-pole form is used as a standard unit, and is connected as a single pole device, with such number in series as the voltage of the circuit demands. The voltage necessary to bridge one gap is 1500 volts, and their custom is to use one gap for each indicated thousand volts. On some very long lines with high voltage the capacity of the cylinders and line causes a small spark to jump one or two gaps, and in this case a few extra ones are added. The low or short gap space enables a very slight increase over the line voltage to discharge to ground, making them peculiarly effective as a means for dissipating the gradual charge to which long lines are subject. Connections for 1000, 2000 and 3000-volt systems are given in Fig. 15.

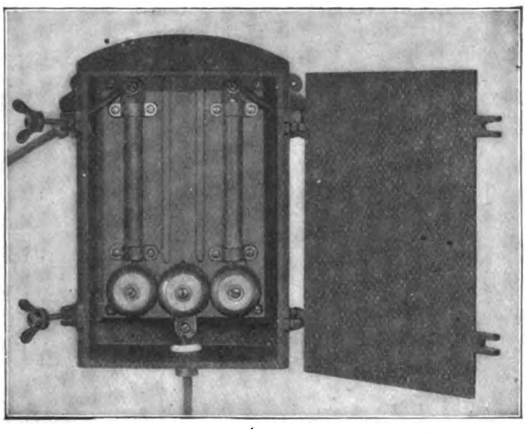


FIG. 14.—1000-VOLT DOUBLE-POLE LINE ARRESTER.

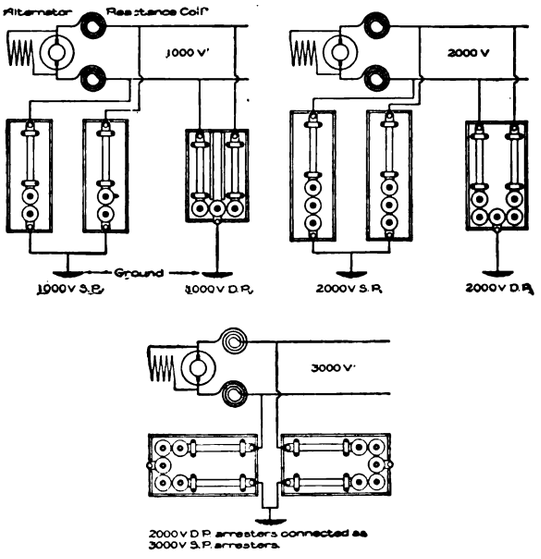



FIG. 15.—CONNECTIONS FOR ALTERNATING CURRENT ARRESTERS.

# Improvement of the Steam Engine.

## IMPROVEMENT IN THE ECONOMY OF THE STEAM ENGINE.

BY PROF. W. F. DURAND.

Having in a preceding article cleared the ground by a discussion of general principles, and of the less available methods for improving steam engine economy, we come now to the methods available for decreasing the amount of water formed on the cylinder wall, and thus of decreasing the readiness with which the heat exchanges take place. To this end, four means may be mentioned: First, compression; second, the splitting up of the entire expansion into a series of stages, each taking place in a separate cylinder; third, the use of superheated steam; fourth, the provision of an additional supply of heat to the steam while on its way through the engine.

Compression we may dispose of briefly. The steam shut in by the closure of the exhaust valve is compressed by the absorption of mechanical work from the engine, and its temperature is correspondingly raised. The cylinder walls absorb heat from this steam and become, in turn, raised to a somewhat higher temperature. The action is quite incomplete, however, and aids but slightly in preventing the loss we are now considering.

Splitting up the expansion into a series of stages produces the multiple expansion engine; compound, triple, etc. In such case all the heat used or wasted in the high-pressure or first cylinder is passed on to the next following, and so on. The use of the heat in a cylinder lower than the first may result in a partial loss, but small in comparison with its total loss as when rejected to the condenser without doing work. In this way the loss due to initial condensation becomes reduced nearly to that in the low pressure or last cylinder, and this, due to the small temperature range in the one cylinder, is small in comparison with the amount which might be expected if all the expansion were to take place in one cylinder only. In a general way, it may be expected that the loss due to initial condensation will be reduced nearly in the ratio in which the number of cylinders or number of stages to the expansion is increased. That is, with a compound the losses will be about one-half those in a simple engine working between the same limits; in a triple, one-third, etc.

Turning to the third method, we have already seen that superheating may conduce toward economy, in so far as it means an elevation of the initial temperature within the cylinder, and an increase in the temperature range. Still more effectively the use of superheated steam conduces toward economy by aiding in the improvement of the thermodynamic cycle, as above described. This favorable effect results from the fact that with a suitable degree of superheat the initial deposition of liquid on the walls may be much decreased, or even entirely prevented. This renders the heat exchanges between the steam and the walls less rapid and less extensive, and thus conduces toward economy, as above explained.

Turning to the fourth means, the additional supply of heat may be provided by means of jackets and by reheaters in the receivers of a multiple expansion engine.

By the use of jackets, heat is supplied through the metal of the liner while the steam is expanded within the cylinder. This is the only method, of course, in the case of the simple engine. By the use of reheaters heat is supplied while passing through the receivers. The action of the reheater is quite similar to that of the surface condenser, except that instead of the heat being withdrawn from the steam it is added to it. The exhaust steam passes either through or around a nest of small tubes, around or through which passes live steam from the boiler. In some cases the waste gases from the boiler have been used as the reheating agent. In either case the heat of the latter passes through the metal of the tubes—and as these are of brass or copper and quite thin, the transfer per square foot of surface is much more effective than in the case of the steam jacket.

We will now briefly compare the application of initial superheating and of reheating to the improvement of the economy of the modern steam engine.

Superheating the steam initially seems to be the more correct in principle, and, aside from its present practicability, the more efficient in action. A wide range of experimental data shows that in comparison with the same engine using saturated steam of the same pressure, gains may be made varying from 10 per cent to 40 per cent, or even higher in extreme cases. Many well-authenticated and carefully performed ex-

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periments show that gains of 20 per cent to 25 per cent may be reasonably expected in simple engines using steam sufficiently superheated to keep it from falling sensibly below the saturated condition while in the cylinder, or, in other words, sufficiently superheated to prevent initial condensation, and its consequences on the transfer of heat to the condenser. This is attended, however, by mechanical difficulties. The necessary elevation of temperature is some 100 deg. to 150 deg. F., or more, above the temperature of saturated steam; and at these temperatures—450 deg. to 600 deg. F.—the superheating pipes, steam valves, piston, etc., are subjected to corrosion and chemical deterioration, while the difficulties of efficient lubrication within the cylinder become very great. With a lesser degree of superheat the gain will be correspondingly less, but even such a moderate elevation of temperature as 10 deg. to 20 deg. shows a well marked gain in economy. With multiple expansion engines the fundamental loss is less, and hence the percentage of gain is less, but even in such cases gains of 15 per cent to 20 per cent have been noted.

Superheating, where practicable, seems on the whole to be superior to any other means for reducing the internal heat loss. Compression offers a very incomplete and unsatisfactory means. Of all those mentioned it is of the least value. Jacketing suppresses only a fraction of the loss and the jackets add to the cost and weight of construction without in many cases yielding a corresponding return. Reheaters are only applicable to multiple expansion engines, and the degree of superheat is limited, though undoubtedly sufficient to materially affect the economy. The splitting up of the expansion into several stages, as in the multiple expansion engine, is efficient to a marked degree, but the method has its limitations and the cost and weight increase with the number of cylinders employed. Superheating distributes the additional heat uniformly through the mass of steam used, and thus it is provided just when and where it is needed. In spite of these advantages of superheated steam, it remains the fact that the mechanical disadvantages connected with its successful use have thus far prevented its general introduction.

While, therefore, high initial superheating may be the most efficient mode of increasing steam engine economy, it does not follow that it is necessarily the most available, especially for multiple expansion engines. For such the use of reheaters seems to offer certain advantages, as follows:

In an engine of this character the loss has already been reduced by the subdivision of the expansion into successive stages, and it then becomes a question of reducing as much as possible the individual loss in each cylinder, or more especially of that in the low-pressure cylinder. Now the number of expansions in each cylinder being small, and the temperature range in the cylinder being correspondingly small, the initial tendency toward cylinder condensation is small and requires a relatively low degree of superheat to successfully overcome or to materially reduce it. Also in the low-pressure cylinder, where it is more especially important to overcome these losses, a relatively higher degree of superheat is the more readily obtained, because the pressure and temperature in the preceding receiver are relatively low, and there will be thus a larger difference in temperature between the live steam and the steam in this receiver, and hence a more rapid flow of heat and greater elevation of temperature, as desired. The degree of superheat which is necessary to be effective in the cylinders of a multiple expansion engine is relatively small, probably not over 30 deg. or 40 deg. F. for each one, while even a smaller degree will produce markedly beneficial results. This amount of superheat is not sufficient to give rise to any mechanical or other difficulty, so that with reheaters, in which the highest degree of superheat will be less than these figures, rather than more, no departure from ordinary constructive practice or mode of operation is required.

The beneficial action of reheaters will therefore be marked in proportion as they are able to superheat the steam passing through them, especially that entering the low-pressure cylinder. As actually fitted in many cases, reheaters are probably able to do little more than to assist in drying the steam as it passes through them. Even then the results are probably beneficial, but in much less degree than when a sensible degree of superheat can be produced.

In all cases where supplementary sources of heat are used in order to decrease losses in the cylinders, it must not be forgotten that whatever saving is effected in the cylinder is at least partly offset by the expenditure in the jacket or reheater. It is the substitution of one loss for another. If the expenditure in the jacket equals the saving in the cylinder, as may be the case, then the apparent saving disappears entirely, or in extreme cases it might even be turned into a net loss. Usually, however, the expenditure of a certain amount of heat in a jacket or in a reheater will prevent a much larger loss within the cylinder and thus leave a balance of net gain. Thus an analysis of experiments shows that in the case of simple engines the expenditure of heat in the jackets resulted in a saving within the cylinders of from five to seven times as much, while in compound engines the ratio of gains to expenses was from three to four.* Equally good, if not better, results are to be expected from the use of reheaters or of initially superheated steam.

To sum up: The one thing needed above all others is to reduce cylinder condensation. The transfer of heat to the condenser by means of the walls with dry or superheated steam is comparatively small in amount. The great loss in the steam engine cycle comes from the exaggeration of this effect due to the presence of moist steam in the cylinder and a layer of condensed water on the inner surfaces.

To this end the use of highly superheated steam is the most effective, but is attended with serious mechanical difficulties. These may in time be overcome. At present they prevent the general use of this means. More moderately superheated steam may be successfully used with good effect especially in the successive cylinders of a multiple expansion engine. In such case it may be satisfactorily provided by means of reheaters between the cylinders, or more especially just before the low-pressure cylinder, where it is the most needed.

The most promising combination at present seems to be the multiple expansion engine (probably not beyond triple), with its naturally decreased loss by condensation, combined with suitable means for moderately superheating the steam between the various cylinders, or particularly before entering the low-pressure cylinder, where the most serious loss is likely to occur.

* Thurston on Superheated Steam. Transactions Am. Soc. M. E. Vol. XVII, p. 511.

# Among our Foreign Contemporaries

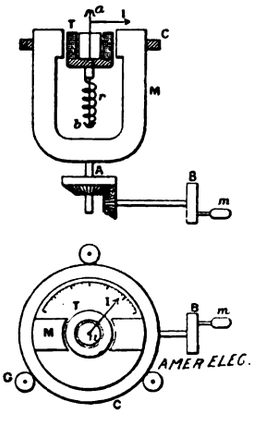
Edited by CHARLES T. CHILD

**Magnifying Telephone Sounds.**—Some very interesting experiments upon the amplification of the sounds of a telephone receiver were described by M. Dussaud, in "Comptes Rendus.' He produced a steady sound by means of an electrically driven tuning fork in front of a microphone transmitter. The receiving end of the circuit was divided into four branches, in each of which was placed a receiver. From various combinations of the four receivers, the author concluded that the more numerous these were the louder would be the sounds. He also found it very desirable to collect the vibrations from both sides of the diaphragm. By employing a set of collecting tubes from both sides of his four diaphragms leading to a resonator of the shape and size of a human mouth, he was enabled to reproduce the sound of wind instruments and the human voice in a large hall accommodating 1,000 persons, with such loudness that they could be heard perfectly well in all parts of it. In experiments conducted on the State telephone system of Geneva, communication was established between the two subscribers, so that the receiver sounds could be distinctly heard in all parts of the room. For this experiment the transmitter battery consisted simply of the two Leclanché cells ordinarily in use for the purpose.

**A Hysteresis Meter.**—In "Comptes Rendus," Prof. André Blondel describes a very simple and beautifully ingenious instrument designed by himself for the measurement of hysteresis of specimens of iron.

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Referring to the illustration, *m* is a horseshoe magnet adapted to be turned about a vertical axis by the handle and gearing. A delicately pivoted axis, *a b* carries at its top a support for holding a cylinder of punched rings of the metal to be tested, *t* and the index *i*, which plays over a scale. On the lower part of the vertical pivot of the apparatus is a helical spring, *r*. It is evident that when the handle is turned and the magnet spun around there will be a corresponding tendency for the bundle of rings, *t*, to turn in the same direction. Readings are taken by swinging the magnet through one complete revolution slowly or rapidly, as the case may be.




BLONDEL'S HYSTERESIS METER.

**Electro Chemistry in Switzerland.**—According to the (London) "Electrical Review," the Swiss Society of Chemical Industry has just opened a competition for a treatise. This is to be of service in aiding the development of the electro-chemical industry in Switzerland, and is, of course, to be on some subject connected with that industry. A premium of $400 is offered to the author of the work winning the competition. The work must be sent to Dr. Henry Schaeppi, president Die Schweizerische Gesellschaft für Chemische Industrie, Mitlödi, Switzerland, by May 1st, 1900. Full particulars of the competition may be obtained from Dr. Schaeppi.

**Acetylene**—Prof. Vivian B. Lewes recently delivered before the Society of Arts (London) a lecture upon acetylene, which was reprinted in full in the "Mechanical Engineer." The history of the gas has been very interesting. Its first public appearance seems to have been at a meeting of the Royal Dublin Society in 1836, when Edmund Davy exhibited the gas. He made it from a black substance, formed when the metal potassium was made by heating calcined tartar and charcoal together. This substance was decomposed by water and yielded the gas, which was then called bicarburet of hydrogen. Over twenty years elapsed before any important addition was made to the knowledge of the subject, when Berthelot began his classical researches in 1859.

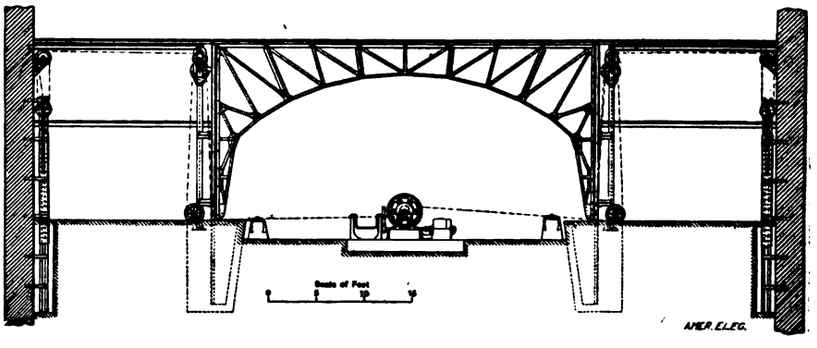
**The Resistance of the Human Body.**—Messrs. Siemens and Halske have been making a long series of measurements, says the "Electrician," upon the electrical resistance of their own workmen and of men employed at the sugar factory at Oschersleben, where recent fatal accidents occurred from low-pressure alternating shocks. It appears that there is absolutely nothing definite about the resistance of the body. Measurements from hand to hand of the men in the sugar factory varied from 900 to 2,000 ohms. Measuring from the hand to earth, the men in each case wearing the wooden shoes customarily worn by German workmen, the resistance varied from 14,000 to over 150,000 ohms. In the evaporating room the resistances lay between 1,700 and 900 ohms. In the boiler house from 1,200 to 3,000 ohms. One man in the repairing shop, who happened to have on new shoes, showed more than 150,000 ohms, the remainder varying from 1,500 to 7,000. All of these measurements go to show that the resistance of the human body is an absolutely meaningless expression, and one that electricians would do well to avoid in the future.

**Pulverization of Metals.**—At the recent meeting of the German Electro Chemical Society, at Leipsic, Herr Bredig read a paper on some applications of the electric arc, which is translated in abstract in "L'Eclairage Electrique." He discovered the curious fact that if an electric arc is established under water between metallic electrodes, such as zinc, lead, platinum, gold or silver, these metals are reduced to an extremely fine powder, which remains in suspension a long time, passing through most filters and giving distinctive tints to the liquid. The suspensions of platinum made in this way do not setttle, even after several weeks. It is probable that the metallic vapors of the arc, condensing instantly in the cold water in the form of a sort of metallic fog, give rise to this strange phenomenon. The author explains that by this extremely simple means, without the aid of any chemical reaction whatever, platinum wire may be converted into very finely divided platinum which has valuable catalytic properties.

**Lighting During Shut-Downs in Large Plants.**—It appears that this question has excited considerable controversy in Europe, as between the relative merits of accumulators or a small unit of engine and dynamo kept in reserve for the lighting of stations during the time when the large machines are shut down. "L'Industrie Electrique" has a short note upon a paper recently read by M. Pierron upon the subject. It describes a little unit found useful for this purpose, consisting of a steam turbine running at 2,000 r.p.m., and direct coupled to a 12-kw. dynamo. It appears that machines of this character have absorbed on power trial only 62 pounds of steam at 145 pounds pressure per kw. hour of output: Or taking account of the low efficiency of the dynamo, a consumption of 40 pounds of steam per h.p. hour upon the low speed arbor connected to the dynamo. This little machine, while not very economical in its steam consumption, serves admirably for the lighting of a large power installation, and costs very much less than the necessary equipment of storage batteries for the same purpose.

In connection with this question, it is worth while for plant managers to look closely into this matter of station lighting as an insurance. It may even be set down as a principle that a station should not be lighted from its own current; even gas, if no other source of current-supply is available, being preferable. This is because a general break-down, such as the explosion of a steam pipe or a boiler, or the breaking of a main shaft, will instantly leave the plant in darkness at just the time when light is needed for repair purposes and, in many cases, to avert a panic among the employees.

**Electrical Stage Appliances.**—At historic old Drury Lane Theatre, in London, a very complete installation of electrical stage appliances has just been put in, says the "Electrician," which also states that this is the first attempt to apply electricity for stage purposes on a really large scale.




ELECTRIC STAGE HOIST, DRURY LANE THEATER.

The plant consists of two big electric elevators, which operate sections of the stage floor, either section being capable of lifting a load of thirty to forty performers, with the ordinary scenery, etc. With the ever-increasing spectacular effects introduced upon the modern stage, where horses, carriages, sometimes even elephants, have to be taken into consideration, the construction has to be very solid; that adopted at Drury Lane being practically railway bridge trusses hung in cables, which are wound upon drums operated by motors. The illustration shows very clearly the method adopted. The sections are almost counterbalanced, each of them

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weighing a little over 4¾ tons. The travel of each is from 6 ft. 6 in. below the stage floor level to 10 ft. 6 in. above it.

**Frequencies.**—An editorial note in "L'Industrie Electrique" gives some very curious facts about alternating current supply stations in England. It appears that that journal has compiled the statistics of the subject, especially examining the frequencies employed." The results of this examination are suggestive, because they show that arbitrary fancy is the only rule to which constructors and engineers deign to submit, if one can consider the absence of all rule to be a rule. In 75 alternating current stations we have found the following frequencies: 40 at Cardiff, Derby and Ealing; 50 at Blackburn, Edinburgh, Hammersmith, Harrowgate, Islington, Portsmouth, Preston, Southport, South Shields, Torquay, Wallasey, Westham, Woolwich; 55 at Sunderland; 60 at Ayr, Bedford, Bray, Croydon, Morby, St. Helens; 67 at Reading, Taunton, Wakefield; 68 at Tunbridge Wells; 70 at Brighton, Carlow; 75 at Burton-on-Trent, Keswick, Salford; 77 at Kingston-on-Thames; 80 at Altringham, Cambridge, Newcastle-on-Tyne, Scarborough; 85 at Blackpool, Bolton, Dublin, Eastbourne, Leeds, London Electric Supply; 85.5 at Lynton, Wokeby, Yarmouth; 85 at Newport; 86 at Halifax; 87 at Coventry; 90 at Hampstead; 95 at Bristol, Cheltenham; 100 at Bath, Bournemouth, Chatham, Chelmsford, City of London, Clerkenwell, Coalbridge, County of London, Brush Co., Dover, Exeter, Hanby, Hastings, Huddersfield, Killarney, Lame, Lynmouth, Metropolitan Electric Supply Co., Newcastle-on-Tyne, Prescott, Sheffield, Wandsworth, Worcester; 125 at Fareham.

At Leicester there are two (50 and 100), two also at Newcastle-on-Tyne, while at Scarborough the frequency varies between 75 and 80, which is delightful for the operation of constant speed motors."

**Platinum.**—The "Mechanical World" describes the platinum deposits of the Ural mountains as follows: "It is nearly all found on the eastern side of the range, the deposits of most value being confined to the districts of Nijni Tagilsk, Gora Blagodat, and Biseik. The first of these localities extends for about twenty-five miles to the south of the village, and, judging from the associated minerals, such as olivine and chromite, the deposits appear to be derived from the débris of a mass of serpentine known as Mount Solvaiska, or the White Mountain. The platinum is found in grains and nuggets—the largest of the latter known, weighing about 320 oz., is in the Imperial Museum at Vienna. The yield varies from 39 to 195 grains per ton. The richest deposits—those of the Martian River—are from 13 to 16 feet thick, and are covered by 60 to 70 feet of overlying material, chiefly clay. The conditions of occurrence in the other localities are similar, except at Gora Blagodat, where the bedrock of the alluvium is limestone, but outcrops of porphyry and serpentine are found in the vicinity."

**The Nernst Lamp.**—The (London) "Electrical Review" abstracts from the "Frankfurter Zeitung" a short description of the new arrangements adopted by Dr. Nernst for his glow lamp. In this lamp the source of light is a rod of magnesia, which is rendered incandescent by the passage of an electric current. If the magnesia is heated to a sufficient point it becomes an electrolytic conductor, but the principal difficulty with the lamp heretofore has been the initial heating of the magnesia, which, when it is cold, is a very perfect non-conductor.

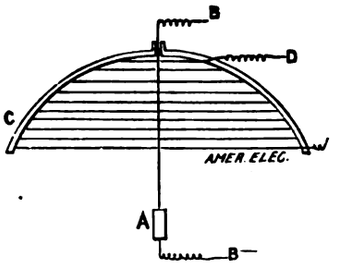



FIG. 1.—NERNST LAMP.

Referring to the diagram, Fig. 1, one of the new arrangements consists in putting the magnesia rod, A, at the focus of a concave reflector, on the inside of which is wound a spiral of platinum, D. This wire is first heated to incandescence by the current, and the heat so focussed upon the magnesia soon renders it hot enough to become conducting when the main current is switched through it.

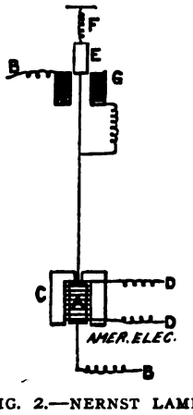



FIG. 2.—NERNST LAMP.

Another arrangement is shown in Fig. 2. Here the magnesia cylinder, A, is placed in a sort of electric oven, C, heated similarly by a coil of platinum wire, while a solenoid, G, is included in the main circuit. When the magnesia is hot and the current turned through it, this solenoid acts against the spring, F, and pulls down the cylinder, A, out of its enclosing oven.

**Becquerel Rays.**—The "Electrician" abstracts an article by Herrn. Elster and Geitel in "Wiedemann's Annalen," upon this most interesting subject. Perhaps the most puzzling question of physics is the origin of uranium rays. Uranium and thorium and some of their compounds have the property of continually sending out rays, called Becquerel rays after their discoverer, which exert photographic effects through opaque substances, and in many ways behave like the well-known Röntgen rays. While the origin of the latter is fairly well known and their nature in a fair way to be explained, the energy displayed by uranium is seemingly in open defiance of the law of the conservation of energy. To account for them, three very daring hypotheses have been put forth. Mme. Sklodowska-Curie supposes that the whole of space is pervaded by rays, somewhat more subtle than the familiar X-rays, which are only absorbed by bodies of high atomic weight, such as uranium. Sir William Crookes thinks that these substances have the strange power of absorbing some of the kinetic energy of molecules of gases impinging upon them,and radiating it in the form of Becquerel rays. A third hypothesis supposes that uranium combines with some unknown constituent of the atmosphere. The authors above referred to have been endeavoring to discriminate between these hypotheses, using a highly efficient uranium pitch ore for the purpose. They tried it in a vacuum and noted no difference. This is a serious blow to both the chemical hypothesis and Crookes' assumption. They then took their uranium to the bottom of a mine, nearly 3,000 feet deep, to see if this would free it from the hypothetical rays of Mme. Curie's hypothesis, but found that that expedient did not affect the uranium. Unless, therefore, these rays are capable of penetrating about 3,000 feet of rock, the last of the three hypotheses is clearly untenable and the question more of a puzzle than ever.

**Electricity and the Supply of Copper.**—The "Mechanical Engineer" gives some interesting figures on the supply and utilization of copper. In 1897 the United States produced 212,000 tons, against 184,000 produced by all other countries, and had a considerable surplus for exportation. The revival of electrical enterprise in the United States, however, may have the effect of reducing this. The Australian output is increasing, but the supply from Spain and Portugal seems to be decreasing; Canada produces a small but increasing quantity; Mexico is increasing her output, while that of South Africa is nearly stationary. One other important copper producing country, Chili, shows a fairly steady increase. No acceptable substitute has yet been found to take the place of copper for industrial purposes, especially for electrical conductors; so that an increase in electrical appliances creating an increased demand makes an increased supply a necessity. Where this is to come from is a question.

So far as electrical conductors in machines such as dynamos are concerned, this seems correct, but there is little need to apprehend any difficulty from failure to find a satisfactory substitute for copper for outside construction work. The price of aluminum has fallen, from one which ranked it with the precious metals a few years ago, to a point at which it already begins to compete with copper as a metal for line

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construction. Possessing many advantages which copper has not and cannot have, such as lightness and freedom from corrosion, it will not require a very much greater cheapening to make it the only acceptable material for transmission lines of whatever character. Meanwhile electrical engineers have strangely neglected the possibilities of iron conductors, and it is only in such recent installations as the Chicago elevated railways that we have seen iron feeders employed with perfectly satisfactory results.

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**The Exhaustion of Gutta Percha.**—The "Engineer" reviews two recent French articles on the danger of the exhaustion of gutta percha, and adds its own note of alarm to the somewhat pessimistic view taken by the two in question.

M. Lazare Weiller, writing in the "Revue des Deux Mondes," seems to have uttered the first warning. He was followed by M. Companaire, who, writing in "l'Electricien," says that the days of submarine cables are numbered. Gutta percha has been discovered nearly sixty years. Ever since the first cable was laid between Dover and Calais, in 1851, the use of this gum as an insulating substance has been an absolute necessity. Innumerable experiments, with a view to substituting other materials for it, have failed, and the attempts have been practically abandoned. A further difficulty has been found in the fact that of the various kinds of gutta percha, only two, produced exclusively in a district a few hundred miles in extent, in the Malay Peninsula, are useful for this purpose. Although several varities of trees produce gum, there is said to be but one method of gathering it, that of cutting down the tree. Contrary to the case of the india rubber tree, simple cuttings made in the bark are not sufficient.

When the report got abroad recently that an American cable was to be laid across the Pacific Ocean, the price of gutta percha rose 40 per cent to 50 per cent in a few days. It is stated that at this moment there are not ten tons of the gum to be found in France fit for use in a submarine cable. Until a new substance shall have been discovered capable of taking its place, there seems to be but one remedy for the gravity of the situation—the formation of nurseries for growing young trees. Unless the trees are to disappear from the face of the earth, they must be preserved, like game. While there is little doubt that Java, Borneo and Sumatra offer favorable ground for experimenting with the cultivation of the tree, nothing has been done to secure the supply of this product, which is absolutely essential to continued intercourse between the nations of the world.

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**Some Swiss Electrical Appliances.**—In the "Bulletin de la Société Internationale des Electriciens" is published a long account of a journey among the various electrical works and installations in Switzerland by the pupils of the Ecole Supérieure D'Electricité, in Paris. It fully describes a number of installations with various methods in use, and among others, the novel and ingenious arrangements illustrated below.

Fig. 1 refers to a rheostat used by a company in Geneva, which is arranged to give a wide variation of resistance by very slow steps. Its arrangement is readily understood from the illustration. The two rheostats of which it is composed are geared together, so that while the tongue of the one on the left is making one complete revolution, that of the other moves forward one step. By making the total of the successive steps on the left-hand rheostat equal

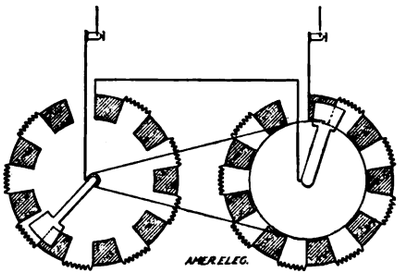



FIG. 1.—SLOW-STEP RHEOSTAT.

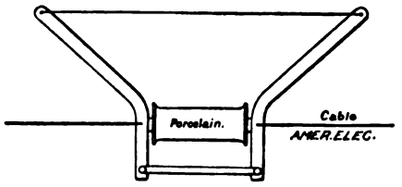



FIG. 2.—HIGH-TENSION MAIN-LINE FUSE.

to one step on the right-hand, it will be seen that by turning the left-hand tongue a sufficient number of times, the whole resistance may be inserted in small steps.

Fig. 2 shows an arrangement for a high-tension fuse in use at Wynau. The porcelain plug in the middle of the apparatus is

Fig. 3o.

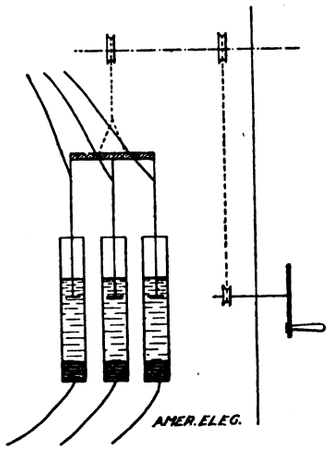



FIG. 3.—STARTING RHEOSTAT AND SWITCH FOR THREE-PHASE MOTOR.

simply a strain-insulator. Between the two copper horns at the ends of this are stretched a large lead fuse wire, of short length, and a very thin copper wire; the resistances of the two being so adjusted that the lead wire becomes hot and melts first. This, of course, shunts the whole current through the fine copper wire, which is instantly volatilized, but it is so long that no arc follows. This instrument is said to have given very satisfactory service.

Fig. 3 shows a very simple starting switch and rheostat for a three-phase motor, which scarcely needs description. At the bottom of the three cups is mercury, upon which floats acidulated water. By the winch and handle arrangement shown on the right, the three contact-pieces can be lowered until full metallic connection is made with the mercury, the resistance, of course, being cut out as they descend through the water.

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**Electrical Machinery in Prussia.**—Some very interesting statistics regarding the growth of the use of electrical machinery in Prussia are given in the "Practical Engineer." It appears that in 1891 there were 983 dynamos in use, of 49,489 total h.p. At the beginning of 1898 there were 3,305 in use, with a total horsepower well exceeding one quarter of a million. During 1897 alone the horsepower employed for driving dynamos increased by 66,800. The purposes to which dynamo-driving power is put show that the electric power industry is quite well developed in that country. In 1897 lighting absorbed 154,772 h.p.; lighting, combined with power transmission, 84,216 h.p.; and motor-driving, 10,785 h.p., the rest being devoted to various miscellaneous purposes.

It would be exceedingly interesting to see some statistics of this kind for American electrical industries. While the Prussian showing is very respectable, it is likely that New York city alone will soon be able to show as great a utilization of electric power.

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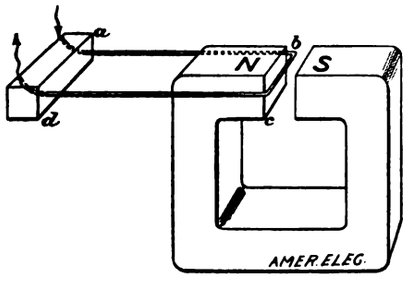
**Space Telegraphy.**—Two very important papers have recently been read before the (English) Institution of Electrical Engineers by Dr. Oliver Lodge and Mr. S. Evershed. Both described researches upon a method of electro-magnetic space telegraphy differing from the familiar ether-wave system of Marconi and from any other that has been suggested as a possible practical method. In brief, it was demonstrated that if two circuits are arranged horizontally, each of considerable size and separated by a great distance, signals may be exchanged between them by the use of pulses of alternating current in the sending circuit and a telephone receiver, or other delicate detecting instrument in the receiving circuit, provided the latter be "tuned," so that its natural period of vibration corresponds to that of the alternator at the sending end. This tuning is easily accomplished by the use of condensers and reactance coils. It was demonstrated that with circular circuits about 65 miles in diameter, of one turn each, the wire being about 0 gauge, that signals could be exchanged at a distance equal to the diameter of the earth.

The demonstration, however, was based upon the assumption that the conducting mass of the earth would exert no appreciable absorption upon the long electro-magnetic waves issuing from a coil of this char-

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acter under the action of an alternating current of ordinary frequency. This assumption is, of course, not warranted, but at present there are no experimental data upon which to base an estimate of the amount of this absorbtive action, while most considerations lead to the belief that it will be very small.

Dr. Lodge has devised a number of receiving instruments, as delicate as they are ingenious, to replace the less sensitive telephone. The fundamental principle upon




VIBRATING LOOP DETECTOR.

which they operate is the vibration in a strong magnetic field, of a very small and light coil. This receives the minute impulses of current and is supported upon a stretched wire, one end of which is attached to a large wooden sounding board. This arrangement may be tuned so as to become extremely sensitive for a note with which it is in unison and not sensitive to accidental disturbances.

The instrument employed by Mr. Evershed is shown in the illustration, which is almost self-explanatory. A loop of hard, non-magnetic wire is arranged, as shown, in the field of a powerful magnet, and is so adjusted that its period of free vibration is equal to that of the electric vibrations it is intended to detect. This very simple arrangement is said to be extremely sensitive and not liable to be disturbed by external influences. Its indications are noted either by the visible vibration of the wire loop, or else by causing this to work a relay contact.

It is probable that this work is the longest step in the direction of space telegraphy over great distances that has yet been taken. Despite the beauty of the ether-wave methods recently so much exploited, it has always been evident that these were strictly limited to short-distance work, and that it would be impossible to extend them to limits much beyond those at present attained. These new systems seem to contain germs of possibility. Whether or not it will be possible to signal across the Atlantic with large wire loops it is not necessary to discuss, but one is fully at liberty to imagine that, should it prove true, the lack of gutta percha, noted elsewhere in these columns, will not be so serious a matter after all.

# Northwestern Electrical Convention.

## SEVENTH ANNUAL CONVENTION OF THE NORTHWESTERN ELECTRICAL CONVENTION.

The seventh annual convention of the Northwestern Electrical Convention, held at Milwaukee, Wis., January 18, 19 and 20, scored another success for that vigorous young electrical body which, though founded but six years ago, has now the largest membership of any similar body in the United States. The attendance was not as large as at some previous meetings, but the character of the papers read and the interest shown in the objects of the association by those present made the meeting an extremely interesting one.

The absence of exhibits curtailed one feature that had added greatly to the liveliness of previous meetings. It was the sense of many present that while the meetings were somewhat better attended than would have been the case if the attention of members had been distracted by a commercial exhibition, it is doubtful if the loss of instruction that would have been received from such an exhibition was compensated for.

In the business discussions, several important points came up, affecting the interests of members from other States than Wisconsin, the final solution of which may result in the broadening of the scope of the association. Many of the Wisconsin members object to being assessed to assist in defeating adverse legislation in other States, the great majority of membership being from the State named. There was also objection to the meetings of the association being held outside of Milwaukee. A suggestion that appeared to meet with favor was that each State should have a separate protective organization, which would do away with the chance of a complication that might sometime affect injuriously the body now accepted as a representative of Northwestern central station men in general, and bring into greater relief its social and educational features.

Very commendably it was voted to hold hereafter but one meeting a year, omitting the midsummer convention. Officers in the future will be elected the last day of the annual meeting, the meeting to be presided over by the retiring president.

President Copeland, in his address, called attention to the fact that though but six years old, the Northwestern Electrical Association has now the largest membership of any similar body in the United States. This success he ascribes to the fact that the association aims to come in close contact with the practical man and to treat the practical questions involved in the every-day operation of central stations; that the large majority of its members are men of the Northwest, whose vitality, self-reliance and eagerness not only to learn but to teach, are great factors toward success; that the cost probably is the lowest of any similar association in the country, and that the combination of business and pleasure which characterizes the programme, and the atmosphere of good fellowship that prevails at the meetings, are strong attractions. President Copeland recommended that only one meeting a year be held, to be convened in January, and that some systematic plan be adopted to compile and issue to members published articles of interest to them, such as articles on municipal ownership, reports of cities operating their own plants, etc. Another suggestion was that the association have a representative at each State capitol in its territory, to examine all bills introduced into the Legislature and report promptly on those that in any way affect electrical interests. He also recommended that the dues of membership be raised to $10 a year and that officers be elected at the end of the convention.

The following officers were elected for the ensuing year: President, Henry L. Doherty, Madison, Wis.; first vice-president, John H. Harding, Laporte, Ind.; second vice-president, S. B. Livermore, Winona, Minn.; secretary, Thomas R. Mercein, Milwaukee, Wis. Board of directors, Col. W. W. Bean, St. Joseph, Mich.; J. H. Culver, Decatur, Ill.; George Innes, Eagle Grove, Iowa.

Below are given abstracts and discussions of the papers read except three, which will appear in the next issue, those reserved being as follows: "Inductive Loads on Alternating Current Transformers," by Prof. D. C. Jackson; "Design of Secondary Currents in Alternating Current Plants," by George L. Thayer; "Electricity Direct from Coal," by Prof. A. J. Rogers.

### THE QUESTION BOX.

At this meeting the new feature of the question box was first tried, but, owing to lack of time, but one question, "What is the best way to enlarge the arc, incandescent and motor capacity of a plant that is now filled up in all departments?" was considered. In answer Mr. Doherty suggested that an alternator with a reserve capacity for future needs be put in and the arc lights near the station be changed over to transformers, cutting them in and out with knife blade switches. Mr. Schott considered that the only way to answer the question, aside from the arc end, is that the true way is to take care of the incandescent and power load by putting it on a meter basis. He said that in one case the arc lights in a large district were changed from series arcs on a flat rate to incandescent arcs on a meter basis, and while during the first year the loss of income was large, the third year showed that the average rate was higher than when on a flat rate basis. Mr. Livermore suggested closer regulation of the plant and the use of 3-watt lamps, or the employment of 3-wire modern transformers; with the latter he made a saving of eight amperes at 1100 volts by replacing 49 old-type transformers with eleven 3-wire modern transformers Mr. Frund said that several years ago, when his plant was well loaded with 4-watt lamps, he substituted 3.1 watt lamps and this avoided putting in new machinery that time. The business was then changed over from a flat rate to meters with a consequence that one 60-k.w.

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machine did the work which previously required two such machines, and the service was more satisfactory. Mr. Thayer spoke of an alternating plant using small transformers and having a 500-volt power circuit and a series arc circuit, which had reached its limit. It was then gradually changed over to two-phase alternators, new transformers and induction motors, the series arcs being retained, but with many extra arcs going on the alternators. Mr. Grover said that in changing from the flat rate to a meter rate he found that the revenue went down the first year about 20 per cent, but that the operating expenses decreased about 33 per cent; while the second year the income increased 50 per cent and the operating expenses still remained about 30 per cent less than previously. Mr. Thayer described a complicated system of charges which he employs. He stated that his company is gradually working over to a meter basis, at present about 40 per cent of the load being on meters.

### SYSTEMS OF METER RATES.

A paper by E. L. Debell discussed the question of flat meter rates and differential charges. Flat rates were pronounced neither logical nor satisfactory. Local considerations should be studied, he stated, in considering the adoption of differential rates, for if little or no demand can be found for current during the station slack hours, even at a very low rate, the success of the system would be doubtful, while if on the other hand, a large demand could be worked up, the system would be highly profitable to the station and prove satisfactory to the public. He stated that a device such as the Wright demand indicator should be useful to stations selling current on the flat rate plan, as monthly rates could be made for each customer, based on the greatest number of lamps they would use at any one time. In the case where a large number of lights were to be used on special occasions, the indicator could afterwards be reset.

Part in the discussion which followed was taken up by Messrs. Thayer, Copeland. Livermore, Grover, Innes, Schott, Norcross, McCullough, Lord and Frund. Mr. Thayer considers that one of the objections to the Wright demand indicator is that it cannot be applied in the case of halls, lodges, theatres, etc., and that there is an expense entailed in the case of residence, since the meter has to be reset after entertainments or when an unusual number of lights are used. These disadvantages, however, he did not think serious, and the system ought not to be condemned for them. Mr. Livermore said that some months ago his plant arbitrarily cut off flat rates and since that time he has secured his best customers. Mr. Grover stated that from the time, three years ago, when the station was changed over to the meter rate, the business has increased almost 100 per cent and is more profitable. After increasing the number of lights by 3200, it was only necessary to purchase 400-light capacity in transformers, owing to the rearrangement of circuits, whereby a number of residences are now on a single transformer. By this means the capacity of the plant was doubled, the revenue is almost double and the ampere output is less than that under the flat rate with about half the number of lamps. Mr. Innes said that owing to the small use of lamps by some of his customers, the bills of some ranged, at times, from 5 to 19 cents per month, the small amount being partly chargeable to the error of meters on a small current. Recently he has informed his customers that in the future the minimum charge would be $1.00 a month. Mr. Debell said that he charges a minimum of $1.00 per month for 16 c.p. incandescents, having first tried the mirimum of 25 and then 50 cents. Mr. Schott described a system of contracts based upon a minimum guarantee with a large discount for any excess. Mr. Debell stated that the rates charged by his company were 15 cents per kw. hour, with discounts varying from 10 per cent on bills amounting to $5.00 or less, up to one-third on bills amounting to $15.00 or more. Mr. Frund said that his company charged a minimum rate of $1.00, or a minimum of not less than 15 cents a lamp.

### UTILIZATION OF EXHAUST STEAM.

J. H. Harding, in a paper gave an account of a system installed in connection with the electric lighting plant at La Porte, Ind., for the utilization of the heat from exhaust steam for residence heating. The Yaryan system was installed at La Porte in 1897 and has since given great satisfaction. In the station house is a storage tank of about 55,000 gals. capacity, the water in which is heated by the exhaust steam to a temperature of 160 degs. The water at this temperature is pumped into the supply main and returns to the tank at a temperature of 130 degs.

The mains are so arranged that the return water can be run back through the tank or pumped direct through a bypath to the return main, a sufficient amount of hot water being taken from the tank to bring the outgoing water up to the desired temperature. The pipes are installed four feet below the surface in a box surrounded by an air chamber; that is, the sides, top and bottom of the box are each of two boards separated by a distance piece. Over the top of the pipes is placed a sheet of asbestos.

In reply to an inquiry, Mr. Harding said there was no sign of decay in the boards, which he ascribes to the fact that the heat from the mains is sufficient to keep dry the dirt in immediate contact with the boards. In the station part of the exhaust steam goes direct into the condenser forming part of the system, and part through a coil located in the bottom of the storage tank. Expansion is provided for every 600 or 800 feet along the mains by an expansion section.

The discussion was participated in by Messrs. Stahl, Thayer, Korst, Debell, Lord, Frund, Norcross, Innes, Doherty, Shott and Copeland. Mr. Stahl added many details relating to the La Porte plant. He said there was no corrosion of pipes, the reason being that the water passed through them was not distilled water, the storage system being supplied with ordinary water. As to distribution, radiators are connected in parallel on the mains and the water flows through all the piping of the building continuously. The drop at an end of a main does not exceed four or five degrees. The temperature of the houses is controlled by raising or lowering the temperature of the water according to the conditions of the atmosphere, both with respect to temperature and wind. The average temperature of the water is 160 degs. for freezing temperature, and the temperature is increased 1 deg. to each degree of drop in the outside temperature. For very low temperatures a back pressure is put on the engine, which increases the temperature of the exhaust and, therefore, of the storage water. During the hours of light load, live steam was formerly used to make up any deficiency, but at present water from a boiler is turned into the system.

Mr. Stahl advises the use of thermostats to keep the temperature of a house constant, and to operate the thermostatic apparatus an air compressor should be set up in the station and a third pipe laid in the boxes, with small taps to convey compressed air into the house. By this means the temperature of a house can be kept absolutely constant, and such a thermostatic arrangement would also simplify the heating system in several respects.

The cost for heating at La Porte is 12½ cents per sq. ft. of radiating surface. In an ordinary eight-room house there would be about 600 sq. ft. of radiating surface, which would bring the yearly cost up to $75. A charge of 30 cents per sq. ft. is made for installing the radiators, $20 for the thermostatic accessory, and $25 for steam connections, making a total cost of $225 for installation.

### CENTRAL STATION DESIGN.

Mr. B. J. Arnold presented a paper on the subject of the present trend of central station design. Mr. Arnold considers that the belted station is obsolete. The latest practice consists of water tube boilers capable of carrying high steam pressure. Mechanical stokers or improved furnaces or grates. Self-supporting brick or steel stacks, the latter costing less than the brick stack and for all practical purposes is equally as good and can be maintained a sufficient number of years to warrant its adoption in almost every case, if properly looked after. High pressure steam piping is not duplicated as was thought necessary by engineers eight or ten years ago. It has become the accepted practice to install as large engines as practicable, and these are almost invariably compound engines where it is possible to condense, and in most cases also when exhausting into the atmosphere. The tendency toward triple expansion engines is not as strong as it was five years ago, as the extra cost scarcely justifies the improved economy. Direct-connected generators of large capacity should be used. The use of economizers will result in an economy ranging from 5 to 7 or 8 and sometimes as high as 10 per cent. Mechanical draft is well spoken of,

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principally where economizers are used, among its advantages being the absence of a smoke pipe and the control given over steaming.

Where water for condensing cannot be cheaply obtained, cooling towers and tables may be used, as they will effect an economy of about 15 per cent. Mr. Arnold believes that there is an economy in the use of electrical driven auxiliaries, such as air and boiler pumps, etc. As to converters, one type consists of synchronous motor driving series arc machines, which will give a combined efficiency of from 72 to 75 per cent, while the efficiency of the rotary converter ranges from 90 to 97 per cent. The rectifier for producing direct from alternating currents is referred to, and Mr. Arnold considers that it deserves consideration in this country, as it would cost much less than a rotary converter and has an efficiency of about 97 per cent. The rotary converter, run as a generator, is recommended, the efficiency of such a machine varying from 92 to 97 per cent. Mr. Arnold believes that the multi-circuit dynamo will be the arc machine of the future if the series arc is to survive. Such a machine will probably not have an efficiency greater than 80 to 82 per cent, and it is therefore open to the same objection as the present series arc machine.

Mr. Arnold referred to three principal types of central station which have lately been built and representing the latest practice. A composite station consists of two or more independent steam units carrying upon the engine shaft direct-connecting generators for light and power, and in addition a fly wheel driving shafting, from which direct-current arc machines or other old style machines derive their power. This type is pronounced admirable for utilizing out-of-date machinery. The second type consists of independent engines carrying direct-connecting generators, and is admirably adapted for plants where but one kind of current is delivered. The third type is known as the Arnold system, which consists of any type of generators mounted on independent bearings upon hollow shafts, and so arranged that either generator is available from two engines. This enables a generator to be released immediately from its engine and taken up from the second engine at once, and this is pronounced the chief advantage of the system.

Were it not for the motor, the alternating current central station would, Mr. Arnold considers, be the ideal one, but at present there is lacking a self-starting motor which will operate successfully on variable loads without seriously affecting the balance of the plant, and also a lamp producing a given amount of light with the same consumption of energy and the same cleanliness as the direct-current enclosed arc lamp. The chief difficulty at the present time is to get an alternating motor for printing press work, which is exacting in the extreme, and for electric elevator work; also a better arc lamp, as the present alternating current arc leaves a slight deposit of ashes, which requires the globe to be cleaned oftener than that of the direct-current enclosed arc lamp, and it absorbs more energy than the latter type.

In conclusion, Mr. Arnold stated that he believed the connecting link between the present direct-current station and the future alternating station lies in the use of rotary converters driven as generators. Mr. Arnold referred briefly to a magnetic clutch he has recently designed, which will transmit 3000 horse power with a consummation of energy of less than one-quarter of a horse power.

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### ELECTRICAL VEHICLES AND THEIR RELATION TO CENTRAL STATIONS.

Mr. H. M. Maxim, in a paper, directed the attention of those interested in central station matters to the probable effect on central stations of the general use of electrical vehicles. After sketching the development of automobiles, Mr. Maxim said that at present the industry is on a firm practical commercial basis and that the immediate future contains the brightest promise. Recently the electric carriage has come into increased prominence, even abroad in the home of the gas and gasoline carriage, and so generally is the value of the former becoming recognized that he believes there are few who will deny but that it is pre-eminently the superior. As to the storage battery for use in electric vehicles both here and abroad, a combination of pasted and solid plates has been adopted. The present state of the art requires that a cell should show a capacity of 3.5 to 4 amp. hours per lb. of cell complete, at a discharge rate of not less than 1.3 amps. per lb. of complete cell, with a possibility of an increase of this rate to 4 or 5 amps. per lb. of cell for short periods without injury, and capable of being charged from empty to full in 3 hours or thereabouts. With a battery coming up to these specifications a mileage of 35 can be obtained under favorable road conditions with an electric phaeton seating two people.

The usual American practice is to equip vehicles with 44 cells in rubber jars, 4 groups of 11 cells each being boxed together. This makes a combination that can be charged from a 110-volt circuit, and 3 speeds can be obtained by merely changing the grouping of the boxes, giving 22, 44 or 88 volts at the motor terminals. While the combination of resistance and the alteration of the field connection of the motors can be used for further speed variation, it is found that the above simple changes in the cell groupings are ample for all purposes.

A description of a Columbia carriage is given as follows: Weight complete, 2000 lbs.; weight of battery, 900 lbs. The controlling apparatus consists of a foot lever connected to a band brake, a steering lever on the driver's right hand, a controlling lever on his left, a push button for a signal bell in the controller handle, and a foot reversing lever, used only preliminary to backing. The carriage can be turned in a 26-ft. circle and can be stopped on the level when going at the rate of 10 miles per hour within 25 ft. The batteries can be charged inside the vehicle when the service demands it, the charging currrent being 40 amps. for three hours. The battery is automatically cut out when filled by combining a recording watt meter with a cut-out magnet, the same meter also registering the discharge on a second scale. Delivery wagons at present are designed for a maximum mileage of 25. An investigation of the daily mileage of the busiest delivery wagons of some of the largest department stores shows that at present a wagon rarely accomplishes more than 18 miles on a single trip. As an example of this class of service it is stated that an electric mail van used in London made six trips per day and a total mileage of 40 with one set of batteries, carrying 1200 lbs. of mail matter each trip. Actual tests of the power consummation by the heavier class of electric vehicles show that 65 watt hours per 1000 lbs. per mile at a speed of 10.5 miles per hour is a conservative estimate, and the expenditure necessary to recuperate the batteries may be liberally estimated at one kilowatt-hour per 1000 lbs. per mile.

The following data are given of a Columbia wagon: Total weight, 4500 lbs, including weight of two drivers and 1000 lbs. of useful load; maximum mileage, 25; weight of batteries, 1500 lbs. The expense of running these wagons on a 15-mile trip would be the cost of 6.75 kw. hours.

From figures obtained from prominent retailers in large cities it appears that the cost of stabling two horses per year is $500, while, on a basis of two trips per day for the electrical wagon, the yearly expense of operation for 300 working days is 4050 kw. hours.

It was pointed out that by charging the batteries of electrical vehicles from central stations, a fairly constant load could be expected until about midday, when there would probably be more or less of peak, which would be followed by an afternoon load and another peak at the close of the day. With the use of electric wagons by a large number of small concerns, a day load approximating a fair degree of constancy could be carried. The operation of a cab or omnibus system would work to even greater advantage to the central station. An omnibus system planned for one of our central cities provides for 9 vehicles, each carrying 12 persons and running under a headway of 5 mins. The route to be traversed will necessitate the expenditure of about one-half the charge of the battery, so that each set can be brought to the full condition in two hours or less. This would, of course, necessitate a change of battery for each trip, and when running on a 5-min. schedule, a total of 24 sets of batteries constantly on the line. At the end of every five minutes a set would be cut out and a new one put on in its place. This would cause a load of approximately 930 amps., diminishing to 880 at the end of five minutes, when it would again rise to the maximum.

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### ELECTROMAGNETIC STRESS.

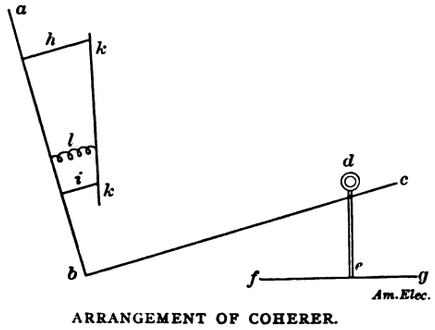
The electromagnetic stress, set up at a given point in the air by a current flowing in a straight conductor of great length, is measured by the quotient of twice the current by the distance of the point from the axis of the conductor.

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## A New Type of Coherer.

*To the Editor of American Electrician:*

Sir—The following may prove of some interest to those engaged in wireless telegraphy. Having for some time past been experimenting on Hertz rays and on the Marconi system of telegraphy, I found than an excellent powder for the Marconi coherer is a simple mixture of about equal parts by volume of silver and carbon filings, together with a very small proportion of iron filings. Very satisfactory results are obtained from the use of such a mixture, the telegraph relay and sounder working admirably with respect to delicacy, clearness and precision. I afterwards became aware that Lodge in England had




ARRANGEMENT OF COHERER.

used carbon in his coherers, but I have not heard that a mixture of carbon and metal had been tried.

Experimenting further I came to the conclusion that coherers could be dispensed with, and succeeded in doing so. This is, I believe entirely new. My method is as follows: Taking a microphone which I had made some years ago, I removed the carbon rod and substituted for it a narrow strip of tin foil which I allowed to hang loosely from the upper carbon support. By a screw in the foot of the microphone I inclined the apparatus until the foil rested lightly against the lower carbon, which I had filed down to a rather sharp edge.

Connecting this with the telegraph relay and sounder in the usual way and joining it in circuit with five "Samson" cells, it worked admirably with the oscillator. This method has an advantage, as one can regulate the pressure of the foil against the lower carbon with a delicate spring and thus receive clear, decisive signals.

The accompanying diagram will explain the apparatus; a, b, c is the microphone stand; d, e, adjusting screw; f, g, table or support; h, i, two-carbon supports; k, k, tin foil; l, spring for regulating pressure.

R. H. BELL, S. J.

St Ignatius College,
San Francisco, Cal.

## Power and Pull of Electromagnets

*To the Editor of American Electrician:*

Sir—Under the title of "The Power and Pull of Electromagnets," in your January, 1899, number, I notice your invitation for experimental research and information contributary to a more intelligent procedure in the matter of the design of electromagnets, and feeling that I can give some suggestions that should prove useful to such ends I offer the following:

At the age of forty I began the study of electrodynamics and have since continued it vigorously for nine years, during which time I have lavishly supplied myself with the literature of the subject. I have had neither tutor, classmate or associate to curb the course of my studies, and I am now heartily glad for it, for I have thus escaped chronic orthodoxy.

My first work was to thoroughly acquaint myself with the most fundamental rudiments of the science, and, of course, believed it all—I believe none of it now-a-days until I have satisfied myself of its truth. At an early day I had my doubts stubbornly aroused concerning one of the most prominent rudiments, and as I could not reconcile its fundamental law I conducted its experiments in opposition thereto and to my ultimate satisfaction in the face of developed facts. Since this occurrence I have had similar experience with others of the elementary laws pertaining to this science. These statements are made in the hope that students may not swallow too much time-honored fundamental law, except, with an added grain of salt.

An electromagnet essentially comprises three functionary elements—a conductor-coil affording the seat for current, a magnetically permeable media enveloping transversely the seat of current, and, an air-gap (usually two) forming a breach in the magnetic enveloping girth and affording the seat for mechanical action due to magnetic tension.

There is no concept more foolishly wrong than the time-honored "ampere-turn," it having been universally offered and accepted as a measure of the current's energy—thus, "a convolution encircling in any manner a portion of the magnetic girth or circuit, said convolution carrying one ampere and contributing unit energy proportional to the circumscribed area irrespective of the length of said ampere-convolution." Instead of the value in "turns," each and every unit of length of conductor carrying an ampere has an exact energy-value capable of being given to a magnetic girth or circuit enveloping it, and exactly proportional to the geometric and the physical constituents of such circuit as a whole. The more permeable, the greater the cross-section everywhere and the shorter the mean length of the media or magnetic girth enveloping the current the more favorable is it for availing the energy of said current.

It should be carefully borne in mind that electromagnetism is never manifest or developed elsewhere than in a completed circuit surrounding the current to which it is due; furthermore, electromagnetic leakage never can exist elsewhere than in completing a magnetic circuit, leakage not performing useful work tending to impoverish said magnetic circuit. The term "core," as applied to any part of the magnetic circuit, is thus wrong and should be banished from use, said circuit invariably being an enveloping member; instead, the energizing copper coil would more truly be the core.

In none of the electrotechnical literature, so far as I can recollect, has there ever been explanatorily recognized a distinction against the "horse-shoe" type of magnet with respect to its windings surrounding the legs or yoke, as contrasted with the advantages of the "ironclad' type, wherein the total mass of the conductor-coil is enveloped by the working magnetic circuit. A study of this fact would show that in the design of a large share of electrical machinery of the present day there exists a shameful extravagance in the use of inert copper, entailing a heavy ohmic loss as well as unnecessary iron in the magnetic circuit, this again requiring additional energetic copper to overcome the added reluctance; and, while it is neither expected nor hoped that the designs should embrace the full advantages of ironclad construction—except in single magnets for traction purposes—it is important that one should understand the true function of each physical element in order to design intelligently.

The foregoing statements should afford a basis whereupon someone having time and opportunity may conduct an interesting and valuable line of experiments, both constructional and quantitive, and though much more could be said upon the subject it is to be hoped that what I have said will bring forth wholesome progeny.

H. C. HECKENDORN.

Philadelphia, Penn.

## NOTES.

**A Large Contract.**—The Third Avenue Railroad has awarded to Westinghouse, Church, Kerr & Company the contract for the boilers, engines and generators for its new power house. There will be sixteen Westinghouse generating units, each of 3000 kw., which will be operated in parallel in groups of four. Sixty Babcock & Wilcox boilers will be used, each having a rated h.p. of 520. Special engines for the plant will be manufactured by the Westinghouse Machine Company.

**Permanent Magnets.**—In some recent experiments on magnet steel, it was found that the intensity of residual magnetism of thirty-five specimens, tested in the form of bars, varied from 220 to 560 gausses (lines per square centimetre). In the case of thirteen specimens tested in the form of closed rings, the intensity varied from 625 to 860 gausses. Assuming an intensity of 700 for a circuit such as is that of magnetos, the section of steel, to produce the same flux, must be about thirteen times greater than if a cast-iron electromagnet were used, or more than twenty times greater than in the case of a wrought iron electromagnet.

**Expert Information.**—A correspondent having asked in a foreign contemporary, the size of wire for secondary distribution from a central point of current from a 40-amp., 1000-volt transformer, is informed that "the proper size of wire for secondaries depends upon the distance apart of transformers, but probably three No. 6 secondaries would be the best!" In the same journal it is denied that "a current of 2500 volts passed through a man's body," in an acci-

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dent alluded to, "as the wire with which he came in contact was not capable of carrying that amount of current."

**Carbon Combination.**—A combination has recently been made which includes all but two of the large arc carbon manufacturing concerns of the United States—the Solar Carbon Manufacturing Company, of Pittsburgh, and the United States Carbon Company, of Cleveland, being the only well-known concerns that did not enter into the combination. The new company, which will be known as the National Carbon Company, is capitalized at $10,000,000, of which $4,500,000 is 7 per cent preferred stock and $5,500,000 of common stock. The companies included in the consolidation are the National Carbon Company, Brush Carbon Works, Standard Carbon Works, Crouse & Tremaine Carbon Company, Thomson-Houston Carbon Company, Faraday Carbon Company, Phœnix Carbon Company, American Carbon Company, Washington Carbon Company and the Partridge Carbon Company.

**Electric Automobiles.**—One of the features of the recent Cycle Show at the Madison Square Garden was a number of exhibits of electrical vehicles. In the exhibit of the Pope Manufacturing Company were shown a phaeton, a double-seated carriage, a dog cart and a delivery wagon. Data concerning the latter will be found in an abstract, printed elsewhere in this issue, of a paper read by Mr. H. M. Maxim at the recent Northwestern Electrical Convention. The Riker Electric Company had also an interesting exhibit, including a tricycle trap, seating two people and weighing with load but 1200 lbs. The same company exhibited an electric carriage and one of a number of delivery wagons built for a New York firm. Another exhibit consisted of a dog cart, shown in the space of the Waltham Manufacturing Company.

**Aluminum for Electrical Conductors.**—The large use of aluminum wire for electrical conductors at Niagara and Snoqualmie Falls, Wash., is directing greater attention to this material as a rival of copper for line wire. The latter plant employs no less than 80 miles of aluminum wire for the tranmission of power to Seattle and Tacoma. At Niagara, two 14-in. and four 10-in. mills are now being installed to further increase the output of this wire. In comparing the two materials we find that copper is 3.332 times heavier than aluminum, while the latter has but 63 per cent of the conductivity of copper. On a basis, therefore, of 14 cents per lb. for copper wire, for equal conductivity aluminum wire should cost 29 cents per lb. But aluminum wire has the advantage over copper for use as line wire in that on the basis of equal conductivity it will stand a greater tensile strain, thus materially reducing the number of line poles and insulators. Another advantage of moment in special cases is that aluminum is less readily attacked than copper by atmospheric influences and by corrosive gases, such as are produced by some coals. As to price, we understand that aluminum wire is now being sold cheaper than copper wire on the basis of equal conductivity.

**The Keely Motor.**—After an examination of the workshop in Philadelphia where Keely exhibited his various so-called inventions, a committee consisting of Mr. Carl Hering and several other Philadelphia engineers, discovered every evidence that the machines had been operated by compressed air. A reservoir was found concealed underneath the floor, and numerous concealed lines of piping were discovered. There was evidence that in the case of one of the most noted of the Keely motors, there was a belt drive from a water motor, the latter being controlled by means of a pneumatic connection similar to that used in manipulating the shutters of photographic cameras. Some years ago during an exhibition by Keely, Professor Spangler, of the University of Pennsylvania, challenged Keely to cut what purported to be a wire leading to one of the machines, Professor Spangler charging that it was a small tube conveying compressed air. This Keely refused to do, and pretending to become greatly enraged, ended the exhibition. A large number of such small tubes, having the outward appearance of wire as small as a No. 8 or 10, were found concealed in the walls and under the floors of the workshop.

**Standard Lamp Sockets.**—At the sixth annual meeting of the electrical committee of the Underwriters National Electric Association, a report was submitted on "Specifications for Standard Lamp Sockets." Among the requirements suggested is that the standard socket shall be for lamps not over 50 candle-power, nor 250 volts, and that the candle-power and voltage for which the socket is designed must be plainly marked upon it. The socket must contain an insulating material at least 1°1-32 in. in thickness, of such a form as will absolutely prevent the shell from becoming a part of the circuit, even though the wires inside the socket should stray from their position under the binding screws. The cap must contain sufficient room for a knot in the lamp cord. The terminals for the flexible cords must include a turned-up lug, so that the cord may be gripped between the screw and the lug in such a way that it cannot possibly come out. All screws in porcelain pieces must be sealed by a weatherproof compound, which will not melt below 200 degrees F. Bayonet joints, or the equivalent, are recommended for screwing on the case. Points of opposite polarity must be kept 3/64 of an inch apart unless separated by a reliable insulation. The socket shall not allow any portion of the lamp base to project beyond it.

**Electricity From Dirt.**—A Western man claims to manufacture an electrical generator which derives its power from "natural gravitation and dirt." The description, as given in a pamphlet, is as follows: "The electricity is generated by an electric concentrator. It has an armature 3 ins. in diameter and 15 ins. long, which revolves once per hour. The power of the concentrator consists of a holder made of galvanized iron, and resembles a half bushel; in this is placed 150 lbs. of earth or dirt. All that is necessary is to turn the switch, and the light is neat, clean and free from all odors, and it will not blow out when a window is raised. The electricity is produced by the natural gravitation of the earth, the cheapest known method of producing electrical energy. All that is necessary is to wind it up, like a large clock; time required is one minute. For ordinary use, one winding will last a week." The invention, it is stated, "is the product of the ingenuity of Mr. E. A. Maxwell, and is the result of years of application and research, by which he has succeeded in performing that to which has been given without result the energy of many great minds," and his invention "has been pronounced by scientists and experienced men as a superior article." A sketch illustrating the "concentrator" shows two concentric circles, from the outer of which two coiled wires lead to a lamp circuit.

**Reporting Extraordinary.**—A correspondent sends us a newspaper account of an accident which happened to a dynamo tender while attempting to file the slip rings of a rotary converter while in motion. Through carelessness, the file short-circuited two of the rings, between which there was an alternating E. M. F. of 370 volts. In the flash which resulted his hands were quite severely burned, but he was otherwise uninjured. Upon this simple foundation of fact a newspaper reporter produced an elaborate account under the scare heads: "Marvellous! Electric Current of Deadly Strength Fails to Kill! It is said that 11,000 volts of electric fluid passed through this man's bady." Omitting some of the wanderings of the newspaper writer, the report is as follows: "The accident is remarkable in that a current said to have a very high voltage of electric fluid passed through the man's body, and the man yet lives, and will probably recover. In some manner he short-circuited this powerful current of electrical energy. There was a flash, and he was hurled back as though a thunderbolt had struck him. He was found lying on the floor unconscious, and a curious circumstance noticed in connection with the case was that, while unconscious, he talked of electric matters with all the apparent knowledge of an expert in the science of electric power. A few weeks ago this man had the sight of one eye partially destroyed by the discharge of several thousand volts of energy, which hurled him back, but did not pass through his body. The passage of the current through his body yesterday is one of the unexplained marvels of electricity. How it is possible for a man to live after the passage through his body of a current at least six times more powerful than is necessary to cause death is one of those problems which electric experts cannot explain at this time." It would be interesting to know on what information the reporter bases his apparently exact knowledge as to the amount of current required to kill.

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### Northwestern Electrical Convention.

The programme of papers read at the recent Northwestern Electrician Convention was by far the best of any yet presented before the association. The reproach which could have been urged against previous programmes—that many papers of an entirely perfunctory character were included—is one that does not apply in the present instance, for not a single one of the papers read can be thus characterized. In another column are printed abstracts of but three of the papers read and of the following discussions, those excepted being reserved for full abstract in a succeeding issue.

### The Electrical Exhibition.

The great success of the recent Madison Square bicycle show promises well for the Electrical Exhibition to be held in the same place the coming spring. The great revival of business now taking place renders the show particularly opportune at the present time. By holding its meetings in the Garden during the show and lending its support to the enterprise, the National Electric Light Association will benefit itself not only by the large attendance that will result, but from the opportunity thus afforded to its members of investigating through the operative and other exhibits, the very latest developments in the field of electric lighting and power. The time, in fact, has never been so ripe as the present for an electrical show, both with respect to the general public and on account of the large number of those engaged in the industry, aside from delegates to the convention, who will desire pointers as to contemplated summer extensions and improvements now rendered possible by the easy business situation.

### Electrically Driven Auxiliaries.

The superior economy from electrically-driven boiler and air pumps, blowers and other auxiliaries of the boiler and engine department of electrical generating stations, has for some time been recognized by central station and power house designing engineers. In a paper read before the recent Northwestern Electrical Convention, Mr. B. J. Arnold mentions the use of electrically-driven auxiliaries as one of the features of the latest central station design. In another column Mr. F. W. Roller gives an argument in favor of the use of electrical-driven auxiliaries aboard ship, which is supported by reliable data from tests made on board the U. S. S. Nashville, on the consumption of steam by the numerous auxiliary steam engines aboard that vessel. He found that the consumption of steam per indicated h.p.-hour varied from 96.6 lbs. in the case of an electric light engine, to 343 lbs. in the case of a water-service pump. While these figures appear startling, they are confirmed by a test made some time ago on another naval vessel, and there is no reason to believe that the data cannot be duplicated by tests of similar machinery ashore.

Upon these figures Mr. Roller makes an unanswerable argument in favor of driving auxiliary machinery aboard ship by means of electric motors. Unfortunately, owing to the present unsatisfactory condition with respect to naval electrical engineering, we cannot expect an extension of electric power aboard ship such as seems logical in view of the results of the tests made. It would indeed be poor economy to endeavor to effect a saving in steam consumption with the probability that the electrical equipments that would displace the present steam machinery "cannot," according to a recent report of a Naval Bureau, "long be self-sustaining without dockyard electrical work." The lesson that the figures teach, however, is one from which benefit may be derived in shore practice. It is not too much to say that one who at the present time designed a large central station or power house plant without specifying that the auxiliaries are to be electrical driven, would be rightly considered behind the times.

### Efficiency of the Steam Engine.

Of recent contributions to steam engineering literature, the article by Professor Durand, of which the conclusion appears elsewhere in this issue, is the most lucid. After an examination of the principles concerned, Professor Durand shows that the great evil to be combatted in improving the efficiency of the steam engine is cylinder condensation. As the loss from this effect is greatly aggravated by the presence of moisture in the steam and the deposition of moisture on the cylinder walls, the obvious remedy is the use of superheated steam. Unfortunately there are practical difficulties in the way, both with respect to superheating the steam and the effect of high temperatures on the working of the engine. The great use nowadays, however, of multiple expansion engines enables benefit from superheating to be derived through the employment of so-called reheaters in the receivers, and to this use the triple expansion engine lends itself more readily than the compound engine, as the superheating is performed in two stages, and in the most important stage, before admission to the low pressure cylinder, the steam is subjected to a maximum difference of temperature.

The economy of superheated steam is not a new discovery. More than a quarter of a century ago much was expected from it, but the practical difficulties met, to which Professor Durand refers, led to the utter abandonment of the idea, in some cases after an expensive experience. It is interesting to note that Corliss continued

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to derive benefit after others had condemned superheating, by using vertical cylindrical boilers having a large tube surface above the water level. By some of the older engineers it is believed that no small part of the great economy obtained by Corliss in those early days was due to his recognition of the value of superheating, and to the care which he exercised, where guarantees were involved, to allow sufficient tube surface in the boiler steam space for that purpose.

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**Magnetism.**

In a letter printed in another column ("The Power and Pull of Electromagnets"), a correspondent gives evidence of a queer state of mind concerning the basis upon which electrical science rests, and of the qualifications necessary for entering into the realm of scientific investigation and thought. As a preface to a criticism of present electromagnetic theory, the writer states—apparently as a qualification for the function of a critic—that he did not take up the study of electrical science until he had arrived at the age of forty, and is heartily glad of the fact that he has since pursued its study with the assistance of neither tutor, classmate nor associate. In view of this statement, we need not be surprised to find that our correspondent is evidently not aware that electrical science rests upon a solid foundation of experimental fact, instead of upon mere hypothesis and guesswork; and that he confounds speculation with true theory and disputes firmly-established law with dogmatic assertion unaccompanied by experimental proof.

---

Our correspondent first falls into the error that magnetism is a form of energy, or that it necessarily requires energy for its maintenance. Others, we fear, coincide in the last mentioned belief with respect to electromagnets, notwithstanding that they must be aware that a permanent magnet requires no application of energy to maintain its magnetism. Such need to be reminded that once magnetized, a medium no more necessarily requires energy to maintain its magnetic state than a spring requires an expenditure of energy to keep it in a state of compression or extension, or a weight when kept lifted from contact with the earth. In the act of magnetization a certain amount of energy is expended, which energy remains stored up in the medium influenced, and is partly or wholly returned in the form of electric current when demagnetization takes place. To illustrate, when a soft iron ring is magnetized, an expenditure of energy is required to introduce within the ring lines of force, and when the ring is demagnetized, this energy appears in the form of current in the magnetizing circuit, should that be closed.

In the case of a permanent magnet, the molecules once coerced into the state corresponding to magnetization, remain so. In the case of soft iron, however, the absence of molecular coercitive force requires that the magnetizing force be maintained as long as magnetization is to exist. But in maintaining this magnetism, no energy is impressed on the medium magnetized, whether air or iron, the entire energy of the current being expended in overcoming the resistance of the magnetizing coil—that is, in $C^2 R$ loss. In fact, the analogy between magnetism and forces like gravity or resilience is shown by its every application. The analogy with the latter is very exact, for energy is required to compress or extend a spring, none is necessary to keep it in a state of compression or extension, and when returning to its normal state, the energy originally imparted is returned in one manner or another. The constant-potential shunt dynamo furnishes a good illustration of the relation of electromagnetism and energy. As the number of shunt turns are increased the field current is decreased in the same ratio; since, however, the ampere-turns remain the same, the flux is unchanged, but the energy used to overcome the resistance of the coils is decreased directly with the current—this energy being the product of the current by the constant e.m.f. The energy may thus be decreased without limit and yet the same flux maintained.

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Our correspondent evidently considers that the ampere-turn is a mere hypothetical conception as applied to the measurement of magnetic force, whereas it is a direct deduction from experiment, and in accordance with the fundamental laws of the science—the word law being here used, not in the sense of speculation, but as a generalization based upon experimental fact, and at no point in conflict with any fact. Thus, Biot and Savart proved experimentally that the magnetic stress exerted at a given point by a current flowing in a long, straight conductor, is, in absolute measurement, the quotient of twice the current by the distance of the point from the conductor. Laplace showed this to be also a proof that the effect of a current varies inversely as the square of the distance, thus corelating the force of electromagnetism with other central forces, such as gravity. From these facts it was demonstrated, both mathematically and experimentally, that the stress created within a coil is expressed by the product of a constant due to the geometry of the circuit, into the current and number of turns. The truth of this expression is proved every time a galvanometer, ammeter or voltmeter is used, and the ampere-turn is a direct mathematical and experimental deduction from it.

---

In disproof of the correctness of the use of the ampere-turn as a measure of magnetic flux, our correspondent refers to the undisputed fact that every unit of length of a conductor, whether straight or circular, will produce an equal magnetic stress. But Laplace showed that the proof of this was involved in Biot and Savart's experiment, and we are not aware that it has ever been denied. In fact, were this relation not true, the use of the ampere-turn in the manner challenged would be incorrect, for its proof rests upon the very stress equality of each unit length of a turn which is offered as a disproof. As to practical proof, this is furnished by the concordance of the results obtained with the ampere-turn basis of the design of actual machines.

---

As the remarks of our correspondent concerning the relative efficiency of horse-shoe and iron-clad electromagnets are unsupported by experimental proof, they can only be accepted as an expression of opinion or a speculation on his part. In any magnet the useful effect is the magnetic flux—the lines of force—set up. The amount of the useful flux will depend upon the magnetomotive force set up by the ampere-turns, the reluctance of the magnetic circuit and the leakage. With a given number of ampere-turns and a given section of iron and air-gap, the relative efficiency of the two forms will depend upon the length of the magnetic circuit and the leakage. The iron-clad form possesses no superiority in either of these respects, but as usually constructed there is greater leakage than in the ordinary horse-shoe type of field. The fact that no external magnetic effect is produced by no means implies that there is no leakage. The lines of force set up in the plane of any turn of the magnetizing coil tend to close on themselves, and if any circuit other than the main one offers less magnetic resistance, they will close through that circuit, this constituting magnetic leakage. Instead of the iron-clad form of field offering superior conditions for opposing such leakage, the reverse is the case.

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## HOW TO MAKE A STORAGE BATTERY.

BY CECIL P. POOLE.

The accompanying engravings show the construction of a plate and a single cell of storage battery of the Faure type, which may be built with no tools beyond a pair of heavy tinners' shears, a small punch and a slitting saw of the sort used for cutting thin metals.

Each plate is made up of twelve strips of lead cut to the shape shown in Fig. 1; this strip is 0.075 in. thick, 8 ins. long, over all, and ⅞ in. wide. Midway on each edge is cut a square slot, s, 3-16 in. wide and deep; the ends of the strip are cut down to ½ in. in width for a distance of ⅞ in. from each extreme end, and two ⅛-in. holes are punched in the narrow part of the strip, as shown. The edges are folded along the dotted lines until the end view of the strip looks like B, Fig. 1.

Next three rubber forks, like D, Fig. 2, are provided for each plate (not each strip, but each group of twelve strips). Each fork is made from a strip of hard rubber, 3-16 in. thick, ⅝ in. wide and 7½ ins. long; the slit down the center must be just wide enough to admit the thickness of the lead strips forming the plate (A, Fig. 1) with no "lost motion," and must stop exactly 1 in. from the lower end of the rubber. When these rubber forks are ready, a plate is built up in three of them as follows: Cut one of the lead strips in two logitudinally, exactly down its center, and assemble the strips on edge in the rubber fingers so that the end view of the lead part of the structure looks like E, Fig. 2. Fig. 3 shows the face view of the complete plate. The halves of the strip that was cut logitudinally go at the top and bottom of the plate, and are indicated by a and b, Figs. 2 and 3.

After the strips are assembled in the retaining forks, D, D, D, tie the upper ends of the fingers tightly with lead wire so that they clamp the plate; this tie-wire should go just above the top strip, at z, and it is imperative that no material other than lead be used, unless very strong, short rubber bands are obtainable, in which case they may be used. Then cut two strips of lead, C, c, each ⅝ in. wide, and of the same thickness as the lead strips composing the plate; the longer one, C, is 8½ ins. long, and the other one, c, 6½ ins. long. Rivet one of these to all the ends of the plate strips at one extremity of the plate and the other one to the ends at the opposite extremity, using lead rivets. The engraving

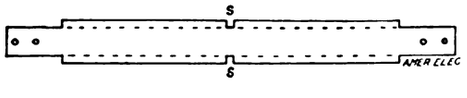



FIG 1.—SHAPE OF STRIP.

shows holes punched in the connecting strips, C, c, to correspond with those in the ends of the plate strips, A. Bend the upper ends of the long connectors, C, about half an inch from the end, at right angle to the main body of the strip; the bending point is indicated by x, Fig. 3. The edges of the plate strips which were bent at an acute angle to the body strips (B, Fig. 1) are designed to serve as shelves to hold the paste or active material which is to be applied to each plate. The process of pasting will be described later on.

After the paste has been put on the plates and has hardened, nine plates (four positive and five negative) are assembled in a glass jar, as shown by the plan view, Fig. 4, where A is the lead portion of the

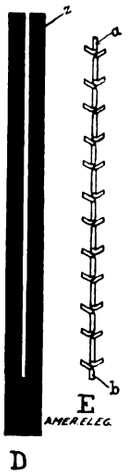



FIG 2.—RUBBER FORK AND PLATE EDGE.

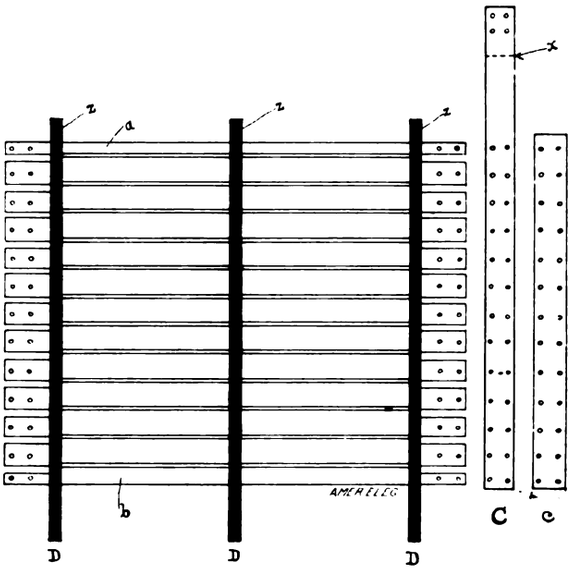



FIG 3.—COMPLETED PLATE.

outside plates; P the paste, or active material; D, the rubber retaining fingers; J the glass jar, and C, c, the vertical connecting strips. The strips, C, are shown coming straight upward instead of bent over, to avoid obscuring the view of the plate ends. The rubber fingers, D, in addition to holding the twelve strips composing each plate in their proper positions, serve to prevent the plates themselves from buckling and shifting in the jar. The edges of these rubber fingers are shown slightly separated, but, as a matter of fact, they must abut each other so as to keep the plates firmly in position. The jar, J, is rectangular, and should be 8¼ ins. long, 5¾ ins. wide and 7½ ins. deep, inside measurement. None of its dimensions can be smaller than specified; if the width or length be greater, a rubber strip of wood may be used to bring it down to the figure desired. A sheet of soft rubber must be laid against each end and side wall of the jar, and the plates must fit snugly against the rubber sheets so that they will not shift in the jar; soft rubber must be used for the wall sheets in order that the plates may expand without tending to buckle.

As above stated, each cell contains four positive plates and five negatives; the two outside plates are negative, and have paste on only *one* side each, as the sides next to the wall of the jar are not active. The terminal strips, C —, on the right hand end of the cell are all negative; those marked C + on the left hand end are the positives, as their signs indicate. The short strips, c, serve simply to connect the parts of the plates to each other, and should not project above the upper edges of the plates.

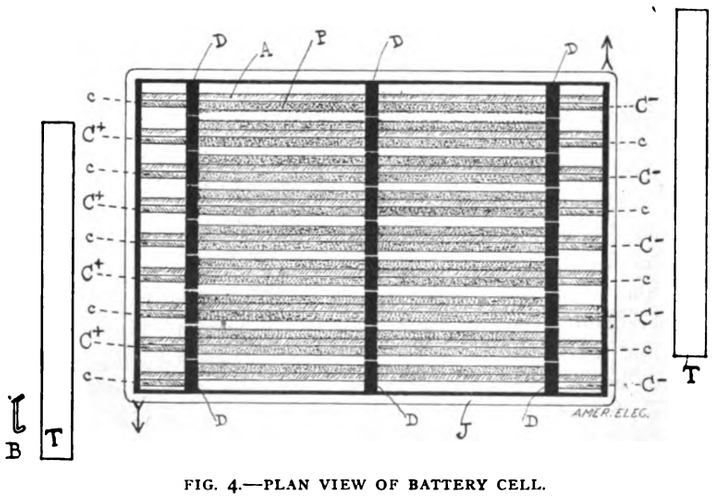



FIG. 4.—PLAN VIEW OF BATTERY CELL.

All the positive ends, C +, at the left are riveted to a lead strip, T, which is laid along the top of the bent-over ends of the strips, C +. The negative connectors are similarly riveted to the other strip, T 2, and these two strips form the terminals of the complete cell. The arrows at the corners of the jar indicate the direction in

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which the ends of the terminals are led from the cells to connect to an adjoining cell or to leading wires, as the case may be.

Each cell of battery of the above dimensions, when properly pasted and "formed" will give an electro-motive force of about 2 volts during the greater part of its discharge, and it may be discharged at the rate of 18 to 20 amperes. To operate any of the small motors described by the writer in the issues of February, April and September, 1897, and February, 1898, four of these cells will be required. (The battery winding given in each article, must, of course, be used on the motor.) After the cells have been "formed" as described below, they may be kept charged sufficiently for light, intermittent service by connecting up 10 cells of gravity battery in series with the four storage cells, the copper terminal of the blue-stone battery being connected to the positive terminal of the storage battery. This connection may be left permanently on, during the use of the storage cells as well as when they are idle, the only attention necessary being the replenishment of the gravity cells at comparatively long intervals.

The plates of the storage cells are pasted, the positives with a thick paste made of red lead and dilute sulphuric acid, and the negatives with a similar paste made of litharge and dilute acid. The acid should be one-tenth concentrated sulphuric acid and nine-tenths water, and the water should be distilled; the proportions of one and nine parts are by weight, not volume. In mixing, always pour the acid into the water, never the reverse. The pastes must be mixed with wooden spatulas in glass or earthenware vessels, and should be so thick (containing so little dilute acid) as to appear almost powdery. The pastes are applied to the sides of the plates and pressed firmly in with the spatulas until the surface of the paste is flush with the edges of the little shelves; the entire surfaces of the lead strips, except the edges of the shelves, must be covered evenly. The best procedure will be to take all the positive plates first; lay them flat on a board, and apply red lead paste to one side. Set them aside and mix the litharge paste (in a separate vessel and with a separate spatula), and then treat one side of all the negative plates. When the plates are all dry, turn them over and treat the other sides, being careful not to jar out the paste already on the under sides. It should be remembered, too, that two of the negative plates in each cell are to be treated on one side only—the side which comes next to the neighboring positive plate.

When the plates are all pasted, assemble them in their cells, as described above, and then rivet the ends of the connectors, C+, and C—, to the horizontal terminal strips, T and T2. Connect the positive terminal of one cell to the negative terminal of its neighbor, and fill all the cells with a solution consisting of one part concentrated sulphuric acid and four parts distilled water, measuring by weight. Connect the series of cells in an arc light circuit, just as though they were arc lamps, and let the current pass through them from the positive to the negative terminal of the series until the paste on the negative plates has all turned color. The cells will then be "formed" and ready for service. They should not be allowed to remain charged long before being put into service, and it will be advisable, therefore, to have the apparatus for which they are to furnish current all ready to start up before putting the cells in circuit for formation. The arc light circuit on which the cells are "formed" may have any current value from 4 to 20, but as most of the circuits in this country carry either 6.8 amperes or 9.6 amperes, one of these values will doubtless be found in the charging circuit.

If the circuit is an intermittent one (does not run constantly, 24 hours a day), care must be observed to take the battery out of circuit as soon as the current is off at each shut-down, so that it cannot discharge in case the line is closed before current is restored.

## TELEPHONE PARTY LINES.

BY H. S. WEBB.

So far there is nothing in the system as explained and illustrated in the preceding section of this article, to prevent any subscriber from taking down his receiver and overhearing a conversation going on between two others, although his local bell has not been rung at all. To accomplish this very desirable feature two current combinations are reserved, one for locking the apparatus at all the stations except at the one called, and the other for unlocking all instruments when the central station operator clears out the line. Six combinations are thus left for selective signaling, so that in the present arrangement there are only six stations on one pair of lines. This is generally a sufficient number, because if more are put on it is apt to result in bad service and dissatisfaction, owing to the fact that one of these subscribers must wait, if the line is busy, till it is clear before he can be served, and similarly some one else on a separate line calling up a subscriber on a party line which is already in use must wait his turn.

Figures 1 and 2 give the diagrams of the system for six subscribers' stations on a pair of lines when locking and unlocking devices have been added. A positive current over the A and B lines in parallel, returning through the earth, is used for locking, and a negative current in place of the positive for unlocking. This leaves a positive current over A to call subscriber No. 1, negative over A to call No. 2, positive over B for No. 3, negative over B for No. 4, positive over A returning through B for No. 5, positive over B returning through A for No. 6. In the last two combinations the lines A and B are in series and the earth circuit is not used at all.

If it is remembered that currents of proper direction only will close the polarized relays, but a current in either direction will open the neutral relays, it will be clear that positive or negative currents over both lines A and B will not call up subscribers Nos. 1, 2, 3 or 4, because a current in either direction will open the neutral relays. Nor will subscribers Nos. 5 or 6 be called up by locking or unlocking currents because they each have two polarized relays requiring a positive current over A and a negative over B, or vice versa, to close both their relays. A current in the wrong direction will leave them open.

In Fig. 2 is shown the arrangement used in each subscriber's instrument for locking and unlocking. R and $R_3$ are the same relays as shown in Figs. 3 and 1. The upper half of Fig. 2 shows the instrument for a subscriber which requires only a positive current over A to ring its bell. $R_3$ is an electro-magnetic apparatus with a closed iron circuit. Over the limb 41 is wound the wire from R, and over 40 is wound the wire from $R_3$, both being wound in such a direction that the flux set up in the iron, by any combinations of currents through 40 and 41 used to call up any

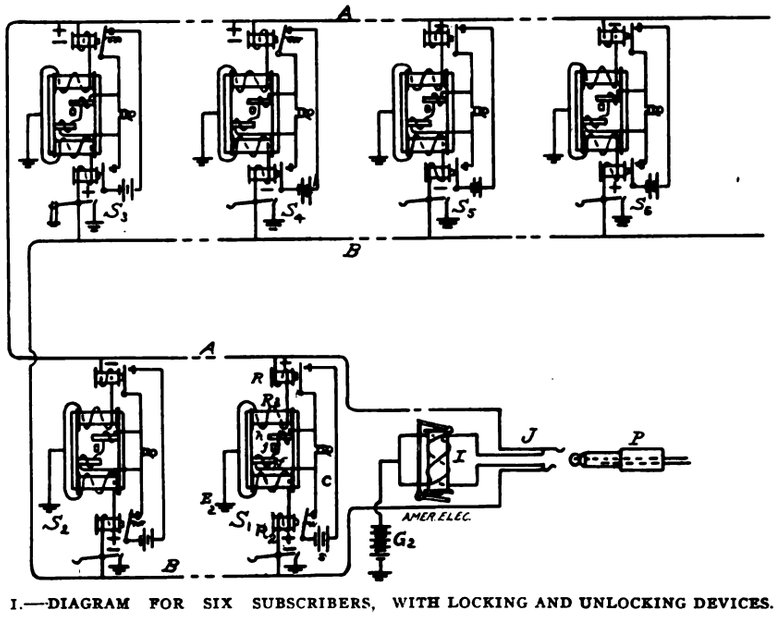



FIG. 1.—DIAGRAM FOR SIX SUBSCRIBERS, WITH LOCKING AND UNLOCKING DEVICES.

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of the six stations, will be in the same direction through the iron yokes connecting cores 40 and 41. That is, the magnetomotive forces producing the magnetic flux are in series, and the cores and yokes form a continuous magnetic circuit of low reluctance for this flux. f and h are soft iron projections, as shown, with a polarized steel armature (j) between them. Coils which are connected in a shunt circuit around the bell D are wound over the soft iron projections f and h. Before any current can flow through these coils both contacts 10 and 11 at relays R and $R_2$, respectively, must be closed; that is, when this subscriber is called up by the ringing of his bell a current will, at the same time, flow through the coils on f and h.

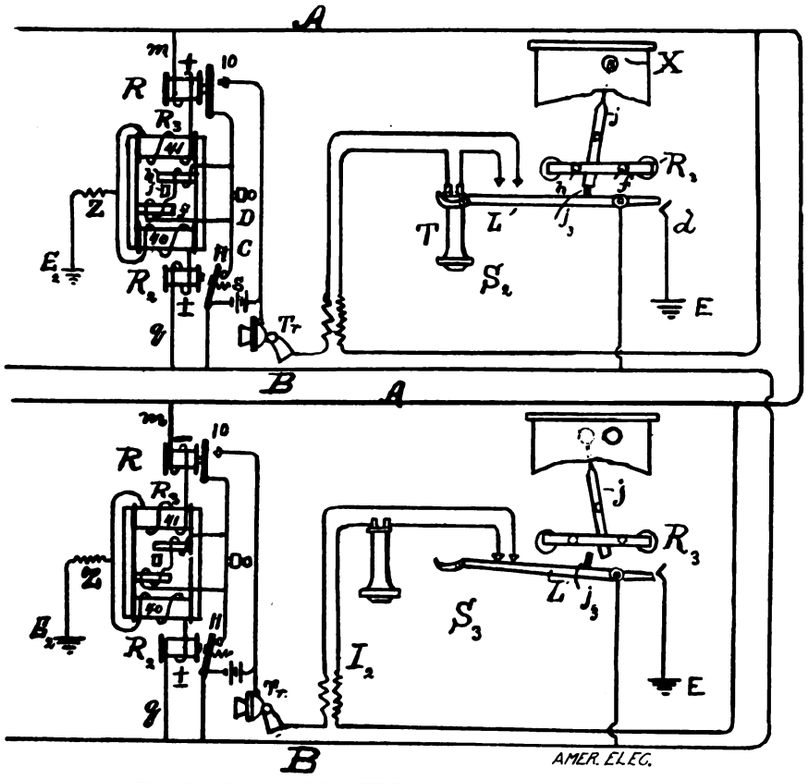



FIG. 2.—DETAILS OF LOCKING AND UNLOCKING DEVICE.

Now in the normal state practically no flux will flow through the high reluctance circuit 40 h j f 40, or through 41 f j h 41, when it can pass through the closed iron circuits formed by the cores and yokes, whose reluctance is much less, since it contains no air gap comparable to the gap between h and j and between j and f, even if the joints between the cores and yokes are bad. Therefore the polarized armature, j, will be unaffected, because the magnetic poles at f and h are too weak. This is the normal condition at all stations.

Suppose the operator desires to call $S_3$. A positive current is first sent over both lines A and B in parallel by pressing the proper key at the central station. This current, passing through 40 and 41 in parallel and returning through the ground, sets up an opposing flux in the yokes, thus causing the lines of force to complete their circuit through h j f, moving the polarized armatures j in such a direction as to lock all the instruments, i. e., by means of the lug $j_3$ it prevents the hook switch from moving up, even though the receiver be removed, and at the same time displays through a hole in the telephone box a busy signal, showing the subscriber that the line is in use and that he will have to wait until a clear signal is shown before he can use his telephone. The lever will remain in its locked position until either the unlocking current (negative over both lines A and B in parallel) or the proper calling current for $S_3$ causes it to be unlocked.

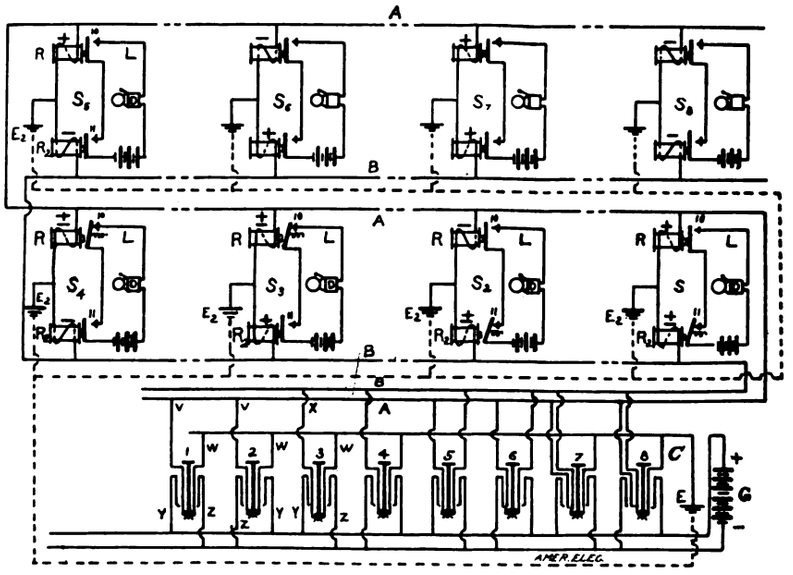



FIG. 3.—DIAGRAM OF CONNECTIONS FOR EIGHT SUBSCRIBERS WITHOUT LOCKING AND UNLOCKING DEVICES.

The operator now presses the proper key to call up $S_3$, that is, a negative current only is sent over line A. Both relay contacts at $S_3$ being closed, the bell rings and at the same time a current flows through the coils on h and f in such a direction as to move the armature j to its unlocked position. All stations except $S_3$ will evidently remain locked, since their coils on h and f have no current passing through them. Thus only the subscriber called can connect his telephone to the line by removing the receiver. When the conversation is ended, the operator unlocks all stations by sending a negative current over both A and B in parallel. This causes the polarized armature j to be moved to its unlocked position and the busy signal to its clear position at all six stations. The locked and unlocked positions of j are shown at $S_2$ and $S_3$, respectively.

The central station annunciator, I, Fig. 1, has two equal coils wound upon the same core. A small, steady current is normally flowing in opposite directions through these two equal coils so that the annunciator is not affected. This same current also flows through the coils 40 and 41 on $R_3$ at all stations, tending to keep all the switches unlocked.

When the line is not in use, all that a subscriber has to do in order to call up the central office is to remove the receiver from the hook. As the rear end of the hook switch moves down, it momentarily touches the spring d, connects line B direct to earth, thereby reducing the resistance of the B line circuit below that of the line A circuit, because the path from B to earth through the rear end of the switch and spring d has less resistance than the path from A to earth through R 41 Z E. Thus more current will momentarily flow through one half of the winding on the annunciator than through the other half, and consequently it will cause the annunciator shutter to drop.

At the central station there are eight separate keys, one for calling each of the six subscribers, one for locking and one for unlocking the receiver hooks. These eight keys are connected to a plug P, as the six keys in Fig. 4 are connected. By the addition of one or a pair of push-button keys to

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each set of cord plug circuits now in use it could be arranged so that in place of using the ordinary alternating current generator for calling this system of eight keys and battery could be connected to the plug line circuit, thus obviating the necessity of having entirely separate plug sets for use on the party lines alone. Thus only one set of eight keys will be required at each section for a multiple switchboard having party line jacks.

S. W. Whittemore later took out another patent by means of which he does away with the polarized magnetic device $R_2$, replacing it with an electromagnet; and furthermore no separate key is needed for locking or unlocking the hook switch.

In this system for selective party lines, Fig. 4, the combinations of relays at the subscribers' stations to close the local battery and call bell circuits and the current combinations required to work these relays are the same, but the locking and unlocking device is entirely different from that described in the previous patent.

This device consists of a double electromagnet and, except the winding, it resembles the self-restoring annunciator used on the bridging multiple switchboard system. As can be readily seen in Fig. 4 the wires from the lines A and B are wound around M, which may be called the locking electromagnet, in opposite directions, then they join at point 7 into one wire, which is wound around N, the so-called unlocking electromagnet, and finally connected to earth. Opposite the end of the unlocking electromagnet is hung a shutter armature held upright by a hook on the end of an arm controlled by another armature at the end of the locking or double-wound electromagnet. The shutter armature has attached to it a light aluminum vane which serves as a visible busy signal. There is also a pin or lug extending outward from the shutter armature which, when the shutter armature is released, prevents the receiver hook from rising and closing the telephone circuit even if the receiver is removed.

In parallel with the calling bell is an electromagnet, F, which when energized holds the armature K with sufficient force to prevent it being moved by the pull of the electromagnet M. In Fig. 9 the locking and unlocking device is only drawn complete at one station, since it is exactly the same at all other stations.

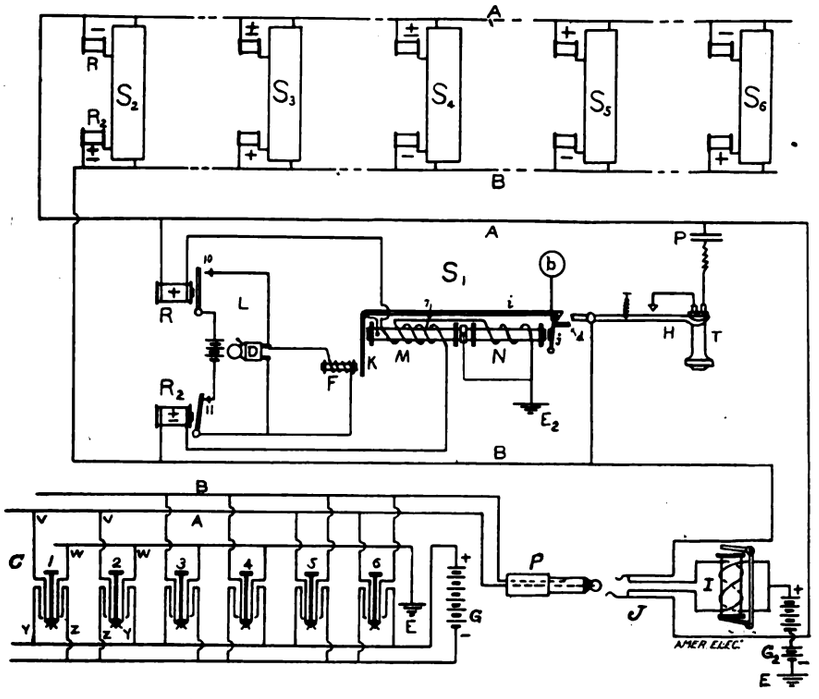



FIG. 4.—DIAGRAM OF SELECTIVE PARTY LINE SYSTEM.

The working of this system is as follows: The lines A and B pass in opposite directions through a differentially wound annunciator at the central station switchboard and through a battery to earth, practically the same as shown in Fig. 2 for the preceding patent. When the line is not in use equal currents from the central station battery flow through the two windings on the annunciator in opposite directions, so that it is not magnetized, through lines A and B in parallel, through all the station relays to earth at $E_2$, energizing N but not M, since the current flows through its two windings in opposite directions. Thus the hook switches are normally held unlocked at all stations by a positive current through the two lines.

When a receiver is removed, while the line is not engaged, the rear end of the hook switch as it moves down (Fig. 4) momentarily touches the rear contact d, thus completing the connection from ground at the subscriber's station, through line B, one half of the annunciator, the generator $G_2$, and to ground E at the central station, thus dropping the annunciator shutter for exactly the same reason as in the system previously described. When the operator inserts the plug into the spring jack the annunciator and battery are cut off.

Suppose the operator desires to call up subscriber S. The plug is inserted into the spring jack and key 1 at C is closed. For the same reason as in the preceding patented system the only local bell circuit which will be closed will be that of subscriber S, and hence this bell only will ring. Furthermore, this operation of ringing up subscriber S will lock the receiver hooks of all the subscribers except that of subscriber S for the following reason. Whenever a key is pressed a positive or negative current circulates in one of the lines A or B or a positive current circulates in one and a negative current in the other line, and the coil M at all the stations will be energized. Under these conditions its core will attract the armature K, the shutter j will fall, and the hook switch H will be locked, except at the station S, whose relays R and $R_2$ respond to the current sent to close the local circuit L, thereby ringing the bell D and magnetizing the core of F, which attracts the armature K and thus keeps it from moving toward the core of M. Consequently the shutter j at station S does not fall, and the hook switch H at that station is not locked.

If the shutters j at the several stations should be attracted by the core of N while a ringing current is traversing the circuit and causing the attraction of the armature K, the shutter will fall after the current has ceased, as it will have passed beyond the reach of the arm i as the latter returns to its depressed position.

When the conversation is over the operator removes the plug from the spring jack, thereby sending positive currents from the battery $G_2$ over both lines A and B in parallel, which currents neutralize each other in the oppositely wound coils M, but magnetize the core N, causing the shutters j to be attracted and to become locked to the arms i.

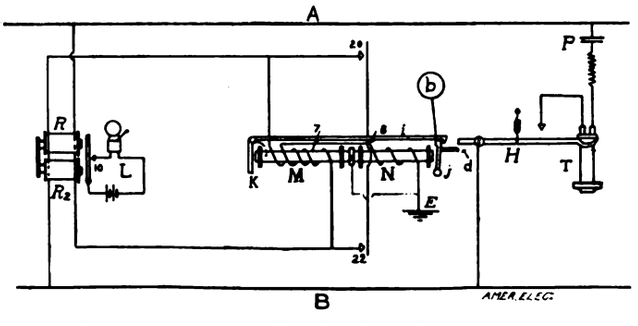



FIG. 5.—MODIFIED SELECTIVE PARTY LINE SYSTEM.

In the modification shown in Fig. 5 the relays R and $R_2$ are combined into one piece of apparatus, and to close the local call bell circuit requires the closing of only

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one contact, and it is thereby easier to keep the signaled station unlocked. In this case the coil M can be prevented from being energized by short circuiting its coils by means of the armature 10 at the station called, as the said armature in falling back to complete the local circuit L can be made to close 20 and 22, which points are connected direct to point 8 between the coils M and N. When 20 and 22 are closed the two coils M are short circuited and no appreciable current passes through them.

The advantages claimed for this system are: First, that of a locking device that cannot be unlocked by jarring the box containing it; and second, an apparatus so constructed and arranged that the act of calling up a subscriber from the central station will automatically lock the other stations on that line, and the mere pulling out of the connecting plug unlocks all the stations, thus doing away with the locking and unlocking keys and at the same time saving the operator the two motions necessary to lock and unlock the telephones. Third, replacing the device for locking and unlocking which required permanent magnets, which are objectionable for various reasons, by apparatus requiring no permanent magnets.

Although this latter system seems to be superior to the former one, where eight keys are used, I do not know that it is in use at all, but I do know that the former is used quite extensively, one local company alone having two thousand instruments installed.

Although no magneto generator is required and a polarized bell is replaced by a simpler vibrating bell, nevertheless the apparatus at a subscriber's station, when either of the two patented systems are employed, is rather complex, and further, their use also complicates matters somewhat at the switchboard. However, this is all much more than offset in having practically six independent subscribers on one pair of lines.

## AN ENGLISH CENTRAL STATION ACCIDENT.

Some time ago the entire supply of the Brighton, England, central station was shut off during the evening, owing to a peculiar accident. The armature of a 220-kw. machine developed a sudden short circuit in its windings, and all dynamos running at the time immediately dropped their circuit breakers, shutting off the whole supply—9000 amps.

The accident having caused considerable discussion in our English contemporaries, the engineer of the station gave the following account (in the London "Electrical Review") of the conditions under which the station was running at the time of the breakdown.

"For the sake of clearness two only of the larger generators are shown in the accompanying sketch, in which F, F are fuses; B, B, bus bar; M, C, O, minimum circuit breaker. It will be noticed that all the dynamos were practically self-exciting and that no battery was in use. All the machines, with the exception of two half-voltage balancing dynamos, were provided with minimum magnetic circuit breakers on one pole and switches on the other, and were without fuses. The other machines were provided with fuses, which were not affected. The shunt circuits derived their current directly from the bus bars, as shown, and were provided with two-way switches and spark-absorbing coils (not shown). By this arrangement any rise of voltage in the shunt circuit at breaking is entirely prevented. Eight generators were running, having a total capacity of 1400 kw. with a load of 1170 kw. The dynamo which gave out is rated at 220 kw. At the time it was fully loaded, and had been running for six hours. A fact of importance is that everything was running quite smoothly, no change of generators being in progress. The possibility of a blunder being the cause is therefore precluded.

"The sequence of events was as follows: The first indication that anything was wrong was a series of loud reports, accompanied by a shower of sparks and molten copper, with a drop of about 50 per cent in the pressure. The light then remained steady for a period of perhaps five or six seconds, and then gradually died out, this taking probably from forty to

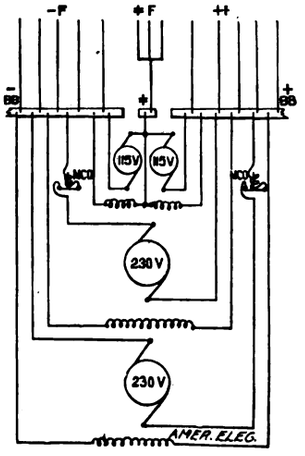



DIAGRAM OF STATION CIRCUITS.

sixty seconds. The circuit breaker of the faulty machine was seen to fall and was badly burned; the falling of the remaining circuit breakers was heard in the dark but not seen. On inspection afterwards, none of these showed any signs of burning on the contacts.

"The switchboard attendant immediately replaced all the circuit breakers, pinning them up, and within four minutes every available generator was running and connected, but doing no work. The feeder fuses were then disconnected, thus throwing off the load, and enabling the dynamos to re-excite, which took a period of seven or eight minutes; when this was accomplished the network was gradually reconnected, fuse by fuse, and everything went on again as usual. The whole shut-down lasted from twenty to twenty-five minutes. A band was found loose on the armature of the damaged machine, and a large hole was burned in the copper bars immediately under it."

In another journal the engineer of the plant expresses the opinion that the cause of the other machines dropping their loads was the combined effect of decreased speed and armature reaction, due to the short circuit, which reduced the fields to zero. The circuit breakers used were all for "minimum current." The engineer states that the use of "non-return" instead of "minimum current" circuit breakers, and the separate excitation of machines, are absolutely essential in this and similar installations to afford complete security from the class of breakdowns that occurred.

## GENERAL METER PRACTICE.

BY LYMAN C. REED.

The testing of meters on the consumers' premises has frequently to be done, and, in fact, is, for various reasons, the best practice if properly carried out. That branch of meter testing will form the subject of the greater part of the present article.

The difficulties encountered in making a reliable test of a light or power meter in circuit have in the past been found somewhat greater than was anticipated. Years ago a lamp bank was employed, but owing to the large size necessary for testing large meters, and also the fact that the consumer was entirely deprived of current while test was going on, it has been abandoned. The volt-ampere meter method is very much used, but where the current is variable, either in potential or amount, this method becomes very inaccurate, and a correct test cannot be made. The indicating wattmeter connected in series with the load is only a modification of the above, and admits of the same serious objections.

Especially are these methods absolutely unreliable when used on direct-connected elevators or other installations where the load is constantly varying. To meet all the varying conditions and at the same time overcome the objections cited above, the following method has been found by the writer to answer the purpose:

A regular stock meter of such type as the ones in use is converted into a portable meter in very short time and at a minimum expense. As we are dealing with the Thomson wattmeter, the method of converting it into the form desired will be given.

We first remove casting which ordinarily fastens the meter to the wall, and place a handle of leather on top of the regular cover. The cover is fastened to the base by the usual bolt and wing nut, with an additional one placed at the back. Four turnbuckles with hooks are provided and fastened to the meter, one on either side of the dial plate, and one in each wooden strip that holds binding poles for inleading wires. The turnbuckles are preferably 1½ ins. long and connected by brass chains.

The portable meter is now suspended under the meter to be tested by means of the hooks, and readily levelled while in this position by the turnbuckles. The two meters are placed in series, and then the

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desired load turned on. The discs are started at the same point, and in a few revolutions it can be seen whether the meter being tested is fast or slow. Any degree of accuracy can be obtained by letting the meters run for, say, fifty revolutions, when it will be seen that a small portion of one revolution will be a fraction of 1 per cent. The meter is readily adjusted if fast or slow. The portable meter is kept standardized by testing after each day's work.

The many advantages of this method can be readily seen, as the consumer is not interfered with in his burning, and can be given a practical illustration of the correctness of his meter. The test can be carried on under the widest variation of load and with equal accuracy, and, in fact, is the only practical way of testing meters on motors where the load is constantly varying. A practical accuracy is obtained free from theoretical errors, errors in figuring, or errors from stop-watch. The mechanical features are equally desirable, as meters, in whatever position they are placed, can be tested with the same ease and quickness. If too near the floor to admit of suspension, the meter is placed on the floor, and the test conducted as before.

Where the current is alternating, this method is about the only correct one if the load is inductive, as the difference between the apparent watts as indicated by volt ammeters, and the true watts, may be such as to give a very inaccurate test by that method. In practice it has been found that from four to five sizes of portable meters are all that are required to test a whole system of either alternating or direct current meters, and the expense incident to inaugurating the system very small.

The question of how often to test meters on circuit can not be decided by a sweeping rule, but must be also a matter of judgment and determined by the locality in which the meter is placed. It is best to err on the right side, and tests of at least twice a year should be made; in some cases much oftener. It has been found in practice that one man can keep a whole system of 2500 meters in perfect condition by testing each meter once in four months, and certainly no evil results can ensue from this practice.

The relation of the consumer and company should always be of a harmonious character, and anything which tends to educate the consumer out of the belief that the meter is more or less a part of the paraphernalia of a "confidence" game, is a direct gain. By all means, let the consumer understand his meter, if possible very thoroughly, and he will then see that he is getting the proper returns for his money, and any number of "kicks" will be avoided. In this connection we have found it good practice to send around to each consumer a printed card or circular, giving exact directions for reading the meter and figuring out the bill. In this way the consumer is enabled to make rough tests of his own by the dial hand, and finds out how much he is burning and when he burns it. That a great many complaints are made which would be avoided if the consumer was in a position to know what he was using has been proven over and over again.

In the discussion of making retests on complaints, the method of charging a nominal amount for the test is a good one. However, the conditions are changed if there is active opposition unless the opposition companies act in unison on this point; otherwise the company that did not charge for tests of their meters would secure the business. Where the meter is found in error and the complaint a justifiable one, no charge should be made, or even where for some cause unknown to the consumer the bill increases suddenly, no charge for the test should be made. The object of charging for a test of the meter is to stop all complaints made with an idea of gaining time or in hope of some rebate on the bill, and it is this class of "kicks" that form the larger part of the complaints.

Our opinion with regard to reading meters coincides so fully with the methods as set forth by Mr. E. A. Leslie in his recent paper before the Electric Light Convention, that I take pleasure in referring all those interested to that paper for a much fuller and better explanation than I can give. I take great pleasure in heartily indorsing this method, because, after several years' trial, we have found it to be an excellent one.

The question of special rates is one which is occupying the attention of nearly all general managers at present, and as yet no definite system has been established on which to operate. This subject lies just outside of the scope of this article, as it only affects meters in the different methods employed to obtain the rates. The consumer's load curve is obtained as nearly as possible, and a rate given from the conditions presented. Two-rate meters are employed in some instances with two dials, and the movement connecting the registering train switched over at fixed hours. Others guess at the consumer's load curve and allow him a rate accordingly. Another method is the one already referred to, of placing two meters in parallel and having the load on each regulated by an automatic switch. Another well-known system is the "Wright Demand." All of these methods are simply modifications of general meter practice, and in some cases call for special devices and special practice outside of any general plan of operating.

Generally speaking, the province of the meter department is to see that all current is accurately measured, and when this is obtained, the minor considerations are relegated to their proper place. If the central station is earning a 10 per cent dividend on $500,000 gross receipts, the amount of dividend is $50,000. If, owing to poor management in the meter department or inaccuracy of instruments used in testing, etc., errors of only 3 per cent are introduced, these affect the dividend directly by this amount, as all operating expenses and fixed charges remain the same as though these errors had not occurred. This instance is cited merely to show how absolutely essential it is to have all parts of the work connected with the testing done as correctly as possible.

We take it for granted that to those interested in the selling of current from central stations, the meter question is probably the leading one of to-day, and when one stops to consider the large gains and losses incident to good or bad meter practice, it proves itself to be a subject well worthy of our best attention.

## SNOW-BOUND STREET-CAR SYSTEMS.

BY WM. HERBERT DONNER.

There are many standards by which it is possible to gage and compare the workings of a street railroad system, but there is no more severe test of what we may call the effective running power than the ability to keep within reasonable touch of the regular schedule during the prevalence of a heavy snowstorm. Doubtless, many people have noticed that, under what may be approximately the same conditions, one road will keep its cars running, by some means or other, while another road will have its power house idle and its cars stalled at different points all along the line.

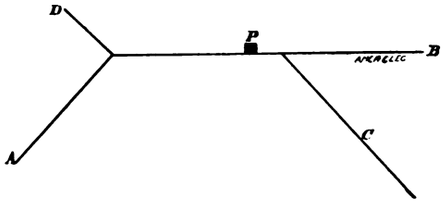
There will be a reason, of course, for each case. The more fortunate system will have more power at disposal with which to clear away the snow, and force its cars along; or its grade will be easy; or its tracks will be less exposed to drifts. But there must be still another and more important reason, and it will generally be found to be true; it is, that the system that can keep its service going has a better hand guiding it, and a head which is clear-sighted and equal to all emergencies. It is not sufficient to provide only the machinery to guard against breakdowns; there must be some well-considered method of operation calculated to successfully meet all conditions and deal with them promptly.

In the matter of sweeping the track there is plenty of room for discretion. The superintendent should understand his road so thoroughly that he will know at once where he may expect the most trouble, and where the snow is likely to form drifts. This may depend somewhat upon the direction of the wind, which should, accordingly, be taken into account. These drifts must be attacked as soon as possible, using a heavy snow plow to cut a way through. The sweepers should be kept running as soon as the snow begins to lie thickly on the ground, and may even be sent over the line earlier, as a precaution. There should be no delay on the score of want of repair, unless there has been some recent accident, for the motor circuits should all be ready tested and everything in running order on the approach of a storm.

It is a very good plan to have sheds for the snow-sweepers at different points on the line; as, for instance, at the junction of branch lines or midway along them, and at each end of the main line, so that the sweepers may be kept there during stormy

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weather, instead of being all bunched together at the central car house, from which several of them may pass over the same track in going out. Suppose, for example, in the accompanying figure, that the power




house is at P; then, if there are sweepers available, they may be located at A and B on the main line, at C on the branch line, and possibly another on lineD, and at the power house.

In the adjustment of the sweeper to the work it is required to do, there is opportunity for a little applied intelligence. During a storm there will inevitably be a heavy strain on the power house machinery to keep the cars running, and any additional power taken to operate sweepers should, therefore, be well used. The writer has seen the brooms set down so far that they bore hard upon the frozen ground, tearing up and scattering small stones and particles of earth along with the covering of snow, and consuming an appreciable amount of power to no useful purpose whatever, as well as subjecting the brooms to a very unnecessary wear and tear. So long as the snow is removed there is no necessity to do more, and the brooms should be set at such a height as to clear off the snow without touching the ground continually. Some men set the brooms to clear the track where the ground is low between, as in the case of T-rails on ties, and neglect to readiust them for higher ground, as, for instance, when entering on paved streets.

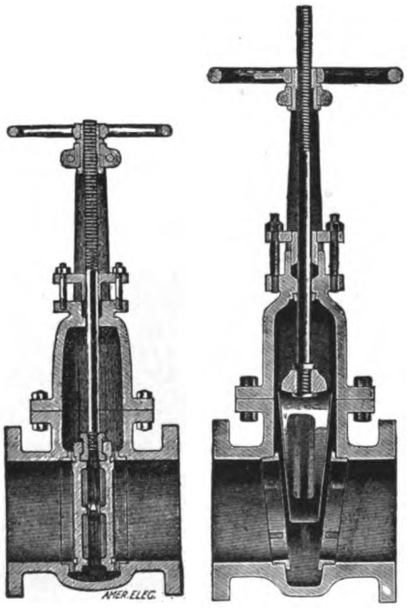
Excuses are frequently made for electric traction systems that get snowed-up, even on roads operating hundreds of cars. We are told that the adhesive force between the wheels and rails is so low that the cars cannot force their way through the snow. There is a remedy even for this. If the road has been neglected during the early hours of the storm, or some accident has prevented the tracks being quickly cleared, there is still no reason to give up while power is available. If the city ordinances will permit, a certain proportion of the cars should be coupled into trains consisting of three or four cars, or more. Stops should be made at correspondingly longer intervals, determined beforehand, even if people get left behind by waiting at the wrong place. Single cars may be run between the trains, making stops as signaled, the number of trains used being determined by the conditions to be met in each case. All the starting bells of one train may be connected to one cord, and one conductor given general charge; or the ordinary method may be employed, as when a motor car and trailer are coupled, of ringing the starting bells in succession. If it is necessary to use a snow-sweeper, and sufficient tractive force is not available from the driving wheels, the same expedient may be used of coupling on one or more heavy motor cars and running them straight through, in the same way as a sweeper alone would ordinarily go.

There are other details concerning the management of street car systems which depend primarily upon the intelligence and vigilance of the person in control, but the perfection of thorough efficiency can be secured only by careful and conscientious study of existing conditions.

## STEAM AND WATER STOP VALVES.

### GATE VALVES.

There are certain cases where plain wedge gate valves are more to be desired than any improved form that raises the disc from the seat before imparting movement to the former. For such cases the valve shown by Fig. 1 was designed by the Kennedy Valve Manufacturing Company. The wedge gate fits between hard bronze seats, and is made for 125 to 250 lbs. steam pressure and superheated steam. The seats in the body can be unscrewed and removed at will, thereby being easily replaced when worn or damaged. This valve has a collar —shown in the engraving—which fits the spindle and closes the bottom of the stuffing box, thereby enabling the valve to be packed without the necessity of closing it. The metal is distributed to withstand not only the strains of the liquid or gas, but the tremendous strains of expansion and con-




FIGS. 1 AND 2.—WEDGE AND PARALLEL SEAT GATE VALVES.

traction are also provided for so that the valve will not be internally distorted thereby.

The same company also manufactures the parallel seat valve, shown by Fig. 2. This form of construction follows the scheme of relieving the disc and seat of pressure through contact with the moving parts, and this is effected in a decidedly novel manner by connecting the two gates to each other by means of heavy right and left hand thread screws, which so connect the discs and are so attached to them that the first turn of the valve spindle removes all traces of pressure between the seats and discs. Fig. 3 shows the discs used, and also the manner in which the screws are arranged. These are so connected with the stem mechanism that they are operated only when the discs are in their seats, either being tightened by the last turn or part turn of the valve stem, or loosened by the first partial revolution of the stem as the valve is being opened. All wedge surfaces or seats are dispensed with by this arrangement of the discs, and, as stated, none but parallel surfaces must be prepared or maintained in the making of the valve. Pressure can be applied at will to either side

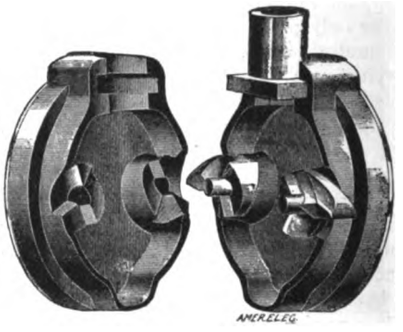



FIG. 3.—RIGHT AND LEFT HAND SCREW DISCS FOR DOUBLE GATE VALVE,

of these valves, and they are made both with and without the by-pass.

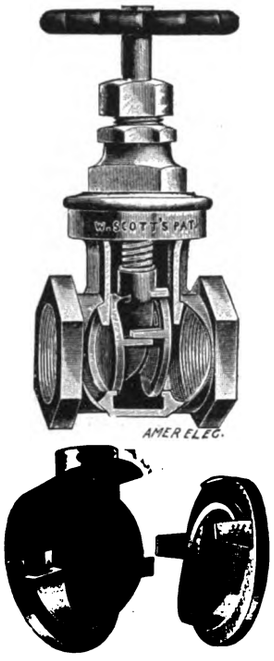
Figs. 4 and 5 show the working parts of what is known to the trade as "Scott Valves," made by the Roe-Stephens Manufacturing Company, and include both the rigid, solid disc and the "collapsible" disc as made by other companies. Fig. 4 shows the general internal arrangement of the Scott valve, and Fig. 5 shows the manner in which the discs are constructed. The maker of this valve states that by the peculiar construction of the cylindrical wedge and the full circular bearing upon the back of the disc or gate, the wear is taken from the face and seat, thus ensuring a perfect seating and the impossibility of the discs springing, bending or getting out of shape. The discs are raised by their lugs coming in contact with corresponding shoulders on the wedge. By the peculiar arrangement of the lugs, the bearing of one disc slightly rotates upon the other, so that the least movement on the stem releases one disc slightly in advance of the other, thereby causing the valve to open easily under the heaviest pressure.

It has always been claimed by some mechanical engineers that a solid disc valve does not allow for unequal expansion; consequently the disc expands more in one place than in another, causing the valve to leak when the closest examination of the valve after it has been removed from service shows not the least thing to cause leakage or failure of the valve. The form given to the above described valve—a full circular bearing—is intended to ensure a perfect seating, and impossibility of the disc either springing, bending or getting out of shape. These valves have no special

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inlet side. On the contrary, they may be connected in any manner, either horizontally, vertically, or, on either side to the pressure.

The Scott valve (Roe-Stephens Manufacturing Company) are made as stated, either solid or double cylindrical, and they




FIGS. 4 AND 5.—SCOTT STRAIGHT WAY GATE VALVE AND WEDGE.

are all made wedge-shaped. None of these valves is made with parallel seats. They are made to stand pressures of from 150 to 300 lbs., the latter being known as "Extreme high pressure gate valves," and tested up to 1000 lbs. hydrostatic pressure. The seats in all these valves are screwed in, and are interchangeable. There is a ground joint under the internal end of

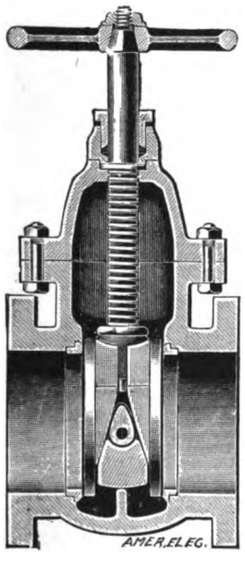



FIG. 11.—PARALLEL SEAT, DOUBLE-DISC VALVE.

stuffing box so these valves can be packed either when closed or fully open.

While some concerns have striven to the utmost to perfect the "collapsible" disc for gate valves, other concerns have confined themselves severely to the solid-wedge form of discs, and contend that this form is the best for any and all purposes. The Crane Company takes this stand, and its valves, one of which—its "extra heavy straightway valve"—is shown by Fig. 6, herewith in section, has a disc cast in one piece with a facing of some other metal dovetailed to the disc. The guides

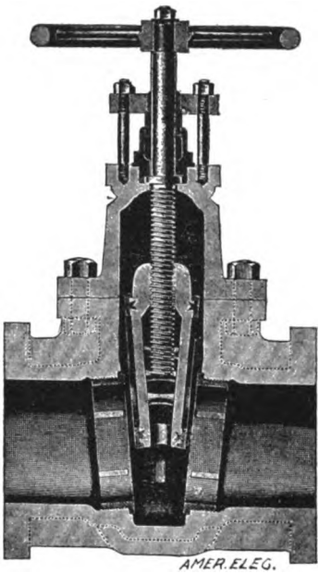
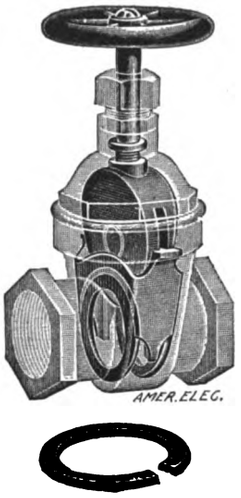



FIG. 6.—CRANE WEDGE VALVE.

on discs and ribs in the body of the valve are fitted and finished very accurately so as to ensure a true and easy movement of the disc, to prevent a wear of the faces, and also to prevent the disc from touching the seats except at the point of closing. The seats and faces of discs are made of brass.

It is only fair to the manufacturers of this valve to state that they make their valves in three groups or qualities—the "Standard," for steam pressures up to 100 lbs.; medium pressure valves for pressures up to 150 lbs., and extra heavy valves for pressures up to 250 lbs. The strength of the valve body is modified in each kind to suit the conditions of pressure. In the "Standard" valves the discs are faced with brass as stated. In the medium pressure valves the facing is of a metal slightly harder, while in the extra heavy valves for high pressures the discs and seats are faced with hard metal throughout, thus reducing steam cutting to a minimum.

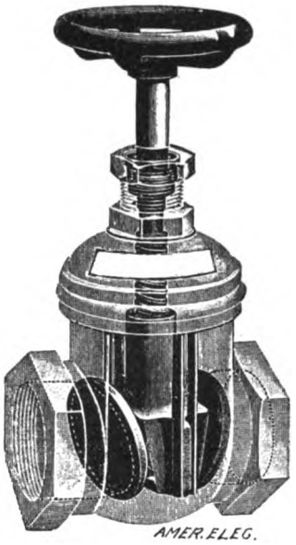
A peculiar form of gate valve is manufactured by the Fairbanks Company, which is known as the "renewable vulcanized asbestos seat gate valve." It is claimed by the manufacturers that the seats, of specially treated asbestos fiber, will not crack, flake or chip off, nor adhere to the gate (or wedge). That they are sufficiently elastic to compensate for the usual expansion and contraction of the valve body, and thus prevent binding or pinching of the gate or wedge while closed. And that being of softer material, they prevent the injury ordinarily resulting from pipe chips, grit, scale, etc., intercepted between them and the wedge. Furthermore, that they

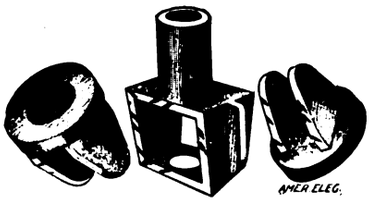





FIGS. 7 AND 8.—RENEWABLE ASBESTOS SEAT GATE VALVE, AND SEAT RING.

are instantly renewable without special tools or skill. The gate is a single casting, wedge-shaped and double-faced, and the




FIGS. 9 AND 10.—THE "S. & B." GATE VALVE, DISCS AND WEDGE.

grooves in its sides slide on the guides in the valve body, holding it in the center and relieving the stem of strain from pressure on either side.

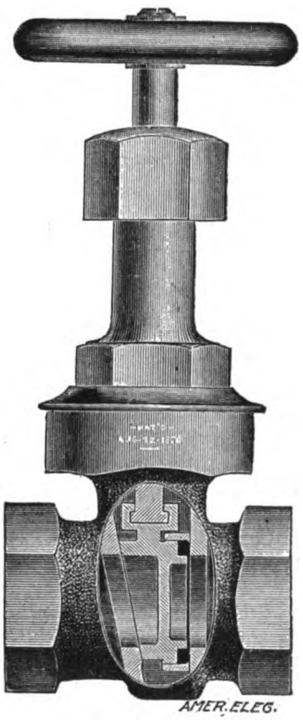



FIG. 12.—JENKINS GATE VALVE.

These valves are made in a considerable variety for all pressures, also for water and acids, and especially for ammonia used in ice-making and refrigerating. One of the

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seat rings is shown by Fig. 8. These rings are provided, when so ordered, with special retaining rings for holding the seat rings in place. This device, however, does not seem to be needed except under very heavy pressures, when it is particularly desirable. Either gate or cock by-pass is furnished with the larger sizes of these valves as desired.

A valve in which the bearings of the wedges come one against the other is shown by Fig. 9. This valve is called the "S. & B." gate valve, and is made by the Nelson Valve Company. This valve is of the double-disc wedge variety, and the bearings of the discs approximate the ball-bearing principle to a certain extent. In operation the rounded ends of the lugs of each disc—shown in detail by Fig. 10—engage the back of the other disc, thereby virtually forming a solid yet elastic and adjustable disc, which is pushed down by the cage on the end of the stem, and the discs slide over the seats at the end of the travel until the valve has been closed sufficiently tight. The movement of opening frees the valves from the valve seats, thus preventing them from dragging across the valve faces.

The advantage is claimed for this valve that if dirt or scale gets under one of the discs it can rock from its position enough to lie upon the obstruction thus encountered. At the same time the other disc is not affected in the least, and the rounded ends of the lugs permit the discs to assume the necessary positions independently of each other.

A valve placed on the market by the Eaton, Cole & Burnham Company has the advantage of parallel seats and a wedging action to throw the discs against the seats. without the least inclination of the discs to be dragged across the seats during the act of tightening or loosening in the last and first movements of the valve stem. The manner in which the wedging action is effected is plainly shown in the cut, Fig. 11. The discs moving down quite near together until nearly across the valve opening. Then the bottom portion of the valve stem strikes a lug on the body of the valve, which prevents the wedge from going farther. The continuing action of the valve stem is thus turned into a lateral motion, which forces the discs apart and against their respective seats. Here the full advantage of rocking discs is obtained at once, and in a very simple manner.

One more valve completes the list of gates, and we will then proceed to examine the globe valve. This valve, the Jenkins (Fig. 12), is different from all the others. It is a "one-sided" valve, for only one side—the vertical one—is expected to make a tight joint upon the seat. This side is vertical and does the stopping act, while the other side is beveled, and does the wedge act to force the disc to a seat. The disc is practically solid, the only separable piece being a ring which is slipped on over the Jenkins packing with which the vertical face of the disc is fitted. This valve can, of course, be used with the pressure in either direction, but the construction of the valve is such that the observing fitter would invariably connect up the valve with pressure against the disc on the vertical side only.

## Electric Cooking.

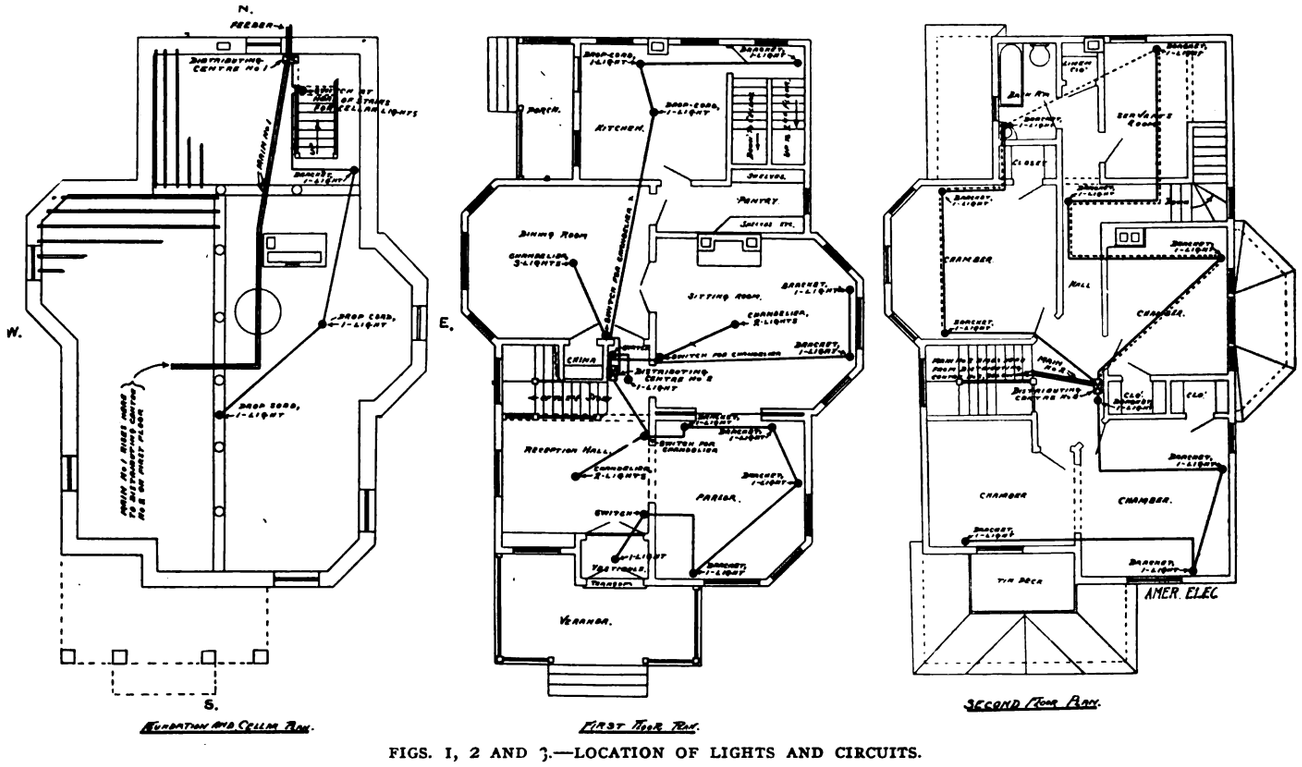
A recent catalogue of electric heating apparatus gives the following data of energy required for the cooking utensils named: Chafing dish, 440 watts; broiler, 1500 watts; griddle (large), 1500 watts; farina boiler, 440 watts; stew pan, 200 watts; coffee heater, 400 watts. The current is found by dividing the watts by the voltage.

## INTERIOR WIRING.

BY CHARLES E. KNOX.

In the preceding articles we have outlined the principal points to be considered in "laying out" the interior wiring in various kinds of buildings. At different times we have selected various types of buildings, by way of example to illustrate some particular feature of interior wiring. Let us now, however, in this number select some particular building, and proceed to lay out the electric light circuit work, from start to finish. This will be by way of resumé of all the preceding articles.

For this purpose, in order to avoid undue complication, we will select a building in which the electric wiring will be extremely simple. The building adopted is one shown in the supplement of the "National Builder" (Chicago, Ill.), of November 15th, 1898, and designed by George O. Garnsey, architect. It is apparently a country residence, consisting of a cellar, two stories and attic. The general arrangement of the rooms, etc., is shown in figures 1, 2 and 3.




FIGS. 1, 2 AND 3.—LOCATION OF LIGHTS AND CIRCUITS.

The building is about thirty-two feet wide, forty-eight feet deep and thirty feet high.

Before starting to locate the lights, it would be well to have three points settled in regard to the installation. These points are: First, what kind of current will be supplied to the building; second, what will be the voltage at the point of supply; third, what rules and regulations will govern the installation.

The necessary information on all three of these points can be obtained from the local company supplying electric current in the town in which the building is located. Let us assume that the building is to be located in a small town, of say 3000 inhabitants. In a town of this size there is very

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little question but that the alternating current system of distribution would be used. The current would probably leave the station at a pressure of either 1100 or 2200 (approximate) and be reduced by means of the transformer at the point to be supplied, to 104 volts. We will therefore assume first that the house is to be supplied with single phase alternating current at a pressure of 104 volts; second, that the transformer will be located on one of the electric light poles near the rear of the house; third, that the installation will be governed by the rules and regulations of the National Board of Fire Underwriters. As alternating current is to be used, it must be borne in mind that owing to induction, any two wires constituting one circuit must be placed in one tube. We may also safely decide that all wires must be inserted in some form of iron tube, having an insulating lining. As the rules are constituted at present it is difficult (and it is well that this is the case) to use anything but iron conduits. Owing to the reduction in the price of iron conduit and to the fact that only one conduit is needed for a circuit instead of two (which is the case, if any other kind is used), it is probably about as cheap as any other kind of conduit.

These points having been settled, we may proceed to locate the lights. Starting with the cellar, we find that three lights will probably be sufficient; one of these should be placed at the foot of the cellar stairs (see Fig. 1), one near the furnace and one in the front portion of the cellar. All three of these lights would better be controlled by a switch located at the head of the cellar stairs as shown.

In the kitchen on the first floor (see Fig. 2), provision should be made for two single lights (cord pendants) one to be located in the center of the room and the other near the range. If the range is to have a hood, this latter should be changed to a receptacle placed under the hood. No switch is needed for these lights, as they may be turned on or off by the key on the socket. Provide a light at the foot of the rear stairs leading to the second story. In the dining room the light will be placed to the best advantage in the ceiling and, unless the ceiling room of the room is such as to invite more elaborate lighting, they should be located at one point as a chandelier in the center of the room. The cubical contents of this dining room is about 2000 ft. (being 13′ 0″ x 16′ 0″ x 10′ 0″) and unless the finish is to be rather dark, a three-light fixture will be ample. If the appropriation for the electrical equipment is sufficient (this, by the way, should be borne in mind constantly in the arrangement of the lights, etc.), it will be well to provide a switch for this chandelier. If, however, it is absolutely necessary to cut down the first cost to the lowest possible figure, the switch will have to be omitted here, as well as in other places. In the sitting room a chandelier in the center of the ceiling with two side brackets would give a good distribution of the light. The brackets are shown between the windows for the reason that they would be useful for reading if a couch or window seat were placed in front of the windows. They could of course, be placed on the south partition wall or else one on each side of the mantel; as the cubical contents of this room is about 2800 ft., the chandelier should have two or three lights and the side brackets, one light each. While a switch is not quite as requisite here as in the dining room, (the chandelier being more easily reached), nevertheless a switch should be provided if the cost will permit. The two side brackets need not be controlled by the switch. In locating the lights in the parlor and reception hall, we must bear in mind the two side brackets need not be controlled by the switch.

In locating the lights in the parlor and reception hall, we should bear in mind, that in these rooms the fixtures themselves should give a decorative effect and their location should be such as to conform with this idea. If side brackets are used here, care should be taken to avoid placing them

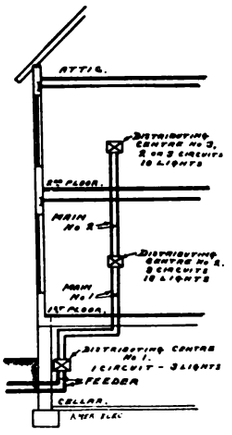



FIG 4.—SECTION OF BUILDING.

where it would be desirable to hang pictures, etc. In the parlor the conventional and less expensive mode of lighting would be by means of a chandelier, but a better effect would probably be obtained by the use of side brackets, as shown. Of course, four lights are more than is absolutely necessary in this room, but they need not be all turned on at once. A switch is not essential for these lights, as they may be turned on by the key on the lamp-socket, unless the fixtures are placed more than 6′ 6″ from the floor. A two-light ceiling fixture would light the reception hall properly unless the color of walls and ceiling was dark. This fixture should be controlled by a switch. A single light (either a receptacle or short-stemmed fixture) should be placed in the vestibule, controlled by a switch from inside. A single ceiling light controlled by a switch should also be placed at the foot of the main stairs.

On the second floor, the two larger chambers (see Fig. 3), should have two lights each, (their cubical contents being about 1700 ft.), while for the smaller rooms one light for each would probably be ample. These lights would be placed to better advantage on the walls than in the ceiling. There should be two side lights in the hall, a single side light in the bath room and one in the servants' room. No switches are needed for these lights. In the next article, the branch circuit will be laid out, and the conductor calculated.

## ECONOMY OF STEAM PRODUCTION.

BY A. L. HARRISON.

Buying coal and paying for the labor to handle and burn it, and then throwing it away in useless waste of heat up the chimney, is so common that if any one man could have an income equal to the waste of this kind in any Western manufacturing district he would hardly exchange income with a Rockefeller.

The district in and about Pittsburgh, Pa., is probably the most prodigal in this respect, because, in the early days of its iron industry coal was almost "as cheap as dirt," and manufacturers bought boilers with principal reference to their possible "crowding" capacity, and thus established a custom of waste which, like all "custom," is slow to yield to more intelligent methods.

As an example of the best practicable economy in a plant of ordinary equipment, there is a flour mill in the Central West which, in the beginning of its history, was a country custom mill; the owner, an energetic, enterprising, progressive business man, developed his business until now, with the aid of three grown sons, this mill has become an 800-bbl. mill, and the largest of several which furnish flour in large quantities, not an inconsiderable part of which is for the export trade. In the evolution of the power plant, a slide valve engine gave place to a Corliss, and it, in turn, was made into a compound condensing engine. The boiler plant grew from one horizontal tubular to three of same type, the amount of steam now required being not more than about double that in the beginning, because of the improved economy in its application or use.

The present engineer, who is unpretentious, but competent and conscientious and devoted to his profession, has been in charge of the plant for several years, and, after the engine had been compounded and all apparent practicable economy secured in application of the steam, turned his attention more earnestly to the possible practicable economy in the production of the steam. The result is that when the mill is running full it requires an average of only about 200 h.p. of steam, including engine, to operate dynamo to furnish lights, the heating of the mill, of the separate office building, and of the proprietor's residence, across the way. As an example of the attention given to details, in the boiler room, the engineer found his gases going off at a high rate, and, as there seemed to be no other better way to save excessive loss from this source, he built a brick flue across the front of the boiler setting of sufficient size to admit inserting a section of coiled pipe, and so arranged as to be accessible for cleaning, through which the feed water passed after leaving heater, and thus reduced the temperature of the escaping gases about 100° F thus

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increasing both the economy and capacity of his boilers, two of which, 14 ft. x 60 ins., supply the steam. Later, when he found there was a large amount of radiation from the sheet-iron flue leading to the chimney, he jacketed the flue, and, by use of a suction blower, drew air through this and discharged it into the mill, thus effecting another economy and relieving the danger of fire, due to the wooden roof of boiler room being unsafely near.

Finally, within the past two years, the Murphy automatic smokeless furnace displaced the hand-fired flat grates, effecting a decided saving in fuel, and insuring a chimney practically as clean as if anthracite were used, instead of the "steam" grade of soft coal, which is used. If an iron truss roof, set at proper height, were to displace the present wooden roof, the boilers reset so as to utilize more advantageously the boiler room space, height of stack increased to 100 ft. or more, and some minor additional conveniences provided for use of the fireman, that little old boiler room and boiler plant would compare favorably in every economic respect with the best in the land.

In this case it will be noticed the furnace or method of burning the fuel or producing and applying the heat, received attention only after every other known practicable source of economy had been provided. In this particular, that engineer is a faithful representative of a large majority, not only of engineers in charge, but also of a very large majority of those interested in the purchase or use of boiler plants. Even of the prominent consulting engineers, few give proper attention to possible practicable economies in producing heat. I venture the assertion that not one in ten knows, even fairly thoroughly, the construction and operation of the furnace referred to, although it has been in prominent use a dozen years or more, or the best arrangement of an ordinary hand-fired furnace, much less the relative merit of the various forms of furnaces in use.

Every person contemplating the purchase of a power equipment, is anxious to secure the most economical outfit practicable, and more or less care is taken in selecting the engine and the boiler, but, in most cases a little or no attention is given to the selection of the form of furnace or setting for the boilers. This is usually left to the boiler company, and I am sorry to say the results show that even the boiler manufacturers fail to give this feature the thought its importance should demand.

Coal is now burned under most of the latest improved boilers, substantially the same as it was 50 years ago, and with about the same waste, due to incomplete combustion and to admission of excess of air. Why this should be so, I leave the reader to answer.

Scientific knowledge surely indicates that decided improvement is possible, and the mechanical furnace for boilers has attained practical success, through application of such knowledge, increasing the volume of $CO_2$, and decreasing the volume of free oxygen, thereby causing the complete combustion of bituminous coal, with consequent higher temperature and prevention of smoke.

Three different recent tests, under varied conditions on one type of this furnace (the Murphy), by Professor R. C. Carpenter, of Cornell University, show superiority in reference to the above essential points in securing improved economy in the burning of western "steam" coal. In view of the evidence accumulated as to the efficiency of the mechanical furnace, it should receive greater attention than it has from consulting engineers who desire to keep abreast of the times.

If clients would insist on the consulting engineer knowing what is best, and why it is best, there would be fewer cases of money wasted on appliances and forms without special merit, and the coal bills would be perceptibly reduced.

In these times of close margins and keen competition, every owner and manager should realize all the economies practicable in producing his steam, whether for power, light or heat.

In the case of electric light or power plants, the cost of coal or fuel is a large and important part of the cost of the product. If a merchant were to negligently disregard a possible ten per cent reduction in the cost of his goods, he would soon find his more enterprising competitors getting profit where he could find none.

There are scores, yes, hundreds of steam plants where ten per cent or more can be saved by enterprising improvement in the method of burning the coal, and in the practice of the boiler room.

Those who take the lead by intelligent improvement in this particular, other things being equal, will soon find they are at the head of the procession.

## Lessons in Practical Electricity

ALTERNATING CURRENTS.

Before again taking up the subject of alternating currents, a brief review of the general principles of the subject will be given, in order that the reader may be more fully prepared to understand the subsequent articles.

There is no doubt but that the subject of alternating currents is in the minds of many surrounded with much mystery. This is partly due to the nature of the subject, and partly to the manner in which it has been expounded, both by so-called practical writers and by those who would conceal the principles concerned, however simple, in complicated mathematical analysis.

In starting out the student should take it for granted that he will meet with more difficulty in understanding alternating than direct currents. The latter branch is in general so extremely simple that the slightest mental labor is sufficient to enable one to obtain a fair knowledge of its principles, and to solve the practical problems which ordinarily occur.

On the other hand, alternating currents introduce the idea of variations, which is one foreign to everyday mental processes, being evaded wherever possible by the use of averages. Nevertheless, there is no real difficulty in understanding alternating currents if the student makes up his mind that some thought is required, and that this he is willing to give to the subject. In fact, what difficulty there is over direct currents is an advantage in the sense that one versed in alternating currents will have fewer competitors.

One caution is necessary for the beginner, which is that he should view with suspicion any explanations of alternating phenomena based upon analogies. An analogy, while it may assist in apparently making clear to his mind one phenomenon, will often render the understanding of other phenomena more difficult if the same analogy does not also apply to them. For example, the phenomenon of inductance is often explained by ascribing the property of inertia to the alternating current. How unsafe this analogy is will be realized when it is considered that it does not apply to circuits carrying alternating currents but containing no inductance; that the value of this so-called inertia is dependent, not only upon the factor of current, but also on the geometry of the circuit and the permeability of the medium; that is, where there is a coil in circuit, upon the number of turns and whether or not any iron is enclosed. Nor does the analogy apply to condensers unless we endeavor to think of such an absurdity as negative inertia.

The great use of mathematics in alternating currents is doubtless a legacy from the time of Joubert, who in 1881 established that the variation of current and e.m.f. in a certain alternator which he tested following the sine law. Up to this time no theory had been attempted of alternating currents such as are generated by commercial machines. In Joubert's celebrated experiments, the machine used was one which happened to give a very close approximation to a sine curve, and this result was eagerly seized upon by mathematical physicists owing to the ideal basis which it gave for building up a complete mathematical theory of alternating currents, the sine curve hypothesis lending itself most admirably to mathematical processes. In consequence of this the treatment of alternating currents became a branch of mathematics rather than that of physics, and only recently has there been a tendency toward a return to a physical basis, or the explanation of the phenomena themselves previous to the application to them of mathematics.

The generation of a true sine-curve of e.m.f. by an actual generator can only be approximated to. If we have a perfectly uniform bi-polar magnetic field, and a wire is revolved in such a field at a uniform rate, then the e.m.f. produced in the wire will vary accordingly to the law of the sine curve. For example, when the wire is at the pole gap, there will be no lines of force cut, since the lines there are parallel to its motion, and, consequently, there will be no e.m.f. induced in the wire; when it is opposite one of the pole pieces, the e.m.f. will

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be a maximum; and between these positions the value of the e.m.f. generated at any point is proportional to the line of the angle between the wire at that point and its position at the gap. Similarly, as the revolution of the wire is continued, the e.m.f. decreases according to the same law until the wire reaches the other gap; then, since the lines of force begin to be cut in an opposite direction, an e.m.f. will be induced as in the first half of the revolution of the wire, but in an opposite direction—that is, the e.m.f. will be negative if it was positive in the first case.

It is always desirable that an alternating current machine shall generate a sine curve e.m.f. for several practical reasons, which reasons, however, were not appreciated by those who built up the sine curve mathematics of the alternating current. First, the line inductive counter e.m.f., or inductive drop, is a minimum when the variation of current follows the sine law. Second, the form of the curve of the e.m.f. of a motor should be identical with that of the generator from which it receives current; there is thus a necessity for a standard form of curve, which standard is best supplied by a sine curve. Third, all of the formulas relating to alternating currents are based upon the supposition that the variation follows the sine law, and would not apply exactly if this were not true; moreover, a mathematical treatment of any other form of variation than that following the sine law would become so complicated as to be almost entirely useless, both theoretically and practically. It may here be remarked that the constant $\pi$ found in alternating current formulas is introduced in most cases by the sine curve hypothesis.

Owing to the distribution of the bi-polar field when a current is flowing in the armature, and to its non-uniformity otherwise in practice, only an approximation to a sine curve would in practice be generated by such a machine. In the case of the ordinary multi-polar alternating current machine, the shape of the pole ends and of the armature slots, as well as the depth of air gap, must all be carefully proportioned in order to obtain the sine curve variation. In fact, in such a machine a smooth core armature with a small air gap and with pole ends concentric with the armature would produce an e.m.f. very far from the sine curve form.

It will thus be seen that in commercial work the sine curve form of alternating current and e.m.f. is attained only through proper proportioning of the parts by the designers of machines, and that it is desirable to approximate to the same curve as near as possible for entirely practical reasons—that the inductive line drop may be a minimum, and on account of the necessity for a standard form of variation, the fact that this form of variation admits of the simplest possible mathematical processes being secondary to the above considerations.

In considering alternating current, mathematicians, as stated before, have treated the subject as if it were a branch of mathematics, and it is for this reason that we read so often of angles, cosines, etc. The beginner has every reason to be perplexed when he reads of electrical currents differing in phase by 90 or 120 degs., or of a current lagging behind an e.m.f. by a certain number of degrees, or of sine waves of current and e.m.f. The idea of angles connected with electrical currents and e.m.f. is an absolutely impossible one to conceive of, if one is dealing with their phenomena instead of their mathematics. In the succeeding article this point will be taken up, and it will be shown that angles, cosines, etc., are introduced, not as properties of the phenomena, but as conveniences in submitting them to numerical calculation; and that naturally alternating current and e.m.f. values add and subtract the same as in the case of continuous currents, vector addition and subtraction being used merely because problems can thereby be solved in a fraction of the time necessary if the natural process were followed.

## Letters on Practical Subjects

### Transforming Direct And Alternating Current Motors.

A letter appearing under the above head in the December issue was contributed by Mr. J. C. Brocksmith, Ithaca, N. Y. The signature attached—J. C. Brown, New York,—belonged to another letter, the printer having inadvertently changed the linotype final slugs.

### A Mild Puzzle.

*To the Editor of American Electrician:*

The writer recently had an experience with a small dynamo that will probably puzzle a good many of your readers and be of interest to those whose knowledge of such machines will enable them to account for the peculiar action of the dynamo in question.

The machine had a six-pole field magnet, built up of ⅛-in. wrought iron laminations, with a 3-16-in. air-gap The armature was cross-connected so as to allow collection with two brushes, which were at diametrically opposite points on the commutator. It was about 1 kw. in capacity, and was belt driven by a 5 h.p. C & C motor during the test. When the field magnet was excited from 110-volt mains, as in Fig. 1, the e.m.f. at the brushes was 100 volts, and a 50 c.p. lamp was maintained, of course, without difficulty. When the brushes were also connected to the mains, as in Fig. 2, the machine ran as a motor at a considerably higher rate of speed, the voltmeter showing 115 volts at the lamp, and the C & C motor being dragged ahead of its normal speed. When the connections, a, b, from the mains of the machine were cut, leaving its field and armature connected as a self-exciting shunt dynamo, as in Fig. 3, the voltmeter at the lamp terminals showed not a particle of e.m.f., and, of course, there was no current. The field simply died out almost instantaneously when the connections, a, b, were cut. What is the solution?

J. C. BROWN.

New York, N. Y.

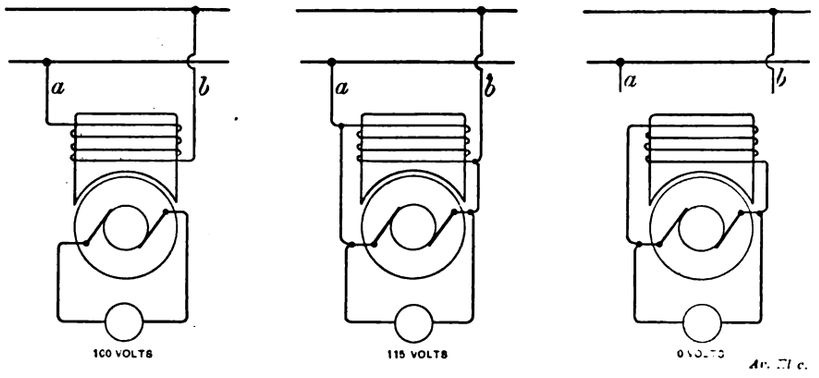
### Series Circuit Lighting.

*To the Editor of American Electrician:*

Sir—Referring to Mr. V. E. Hunter's arrangement for changing over a circuit of series lamps from a two-phased alternator of a given voltage to a single-phased machine of higher voltage, the writer would suggest that the arrangement shown by the accompanying sketch would be much more economical as to both first cost and cost of operation. It consists of using a simple choking coil having means for regulating its counter e.m.f., such as a movable contact, as indicated in the diagram, or a core which may be moved inwardly or outwardly ni the coil, according to the demands of the conditions.

The choking coil will have to be "set" every time the double-throw switch is changed over, just as Mr. Hunter's transformer switch has to be set each time, but a simple choking coil, the maximum counter, e.m.f., of which is equal to the maximum difference between the e.m.f. required at the terminals of the work circuit and that of the alternator, is obviously a much less expensive device than a transformer having a capacity equal to the full load of the circuit, and with an adjustable primary.

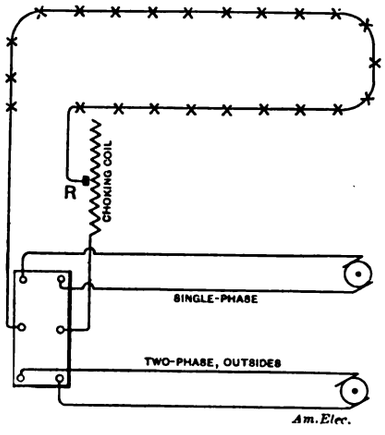
The arrangement of the voltmeter connection, shown by Mr. Hunter's sketch, is very bad, and would be advantageously




FIGS. 1, 2 AND 3.—SHOWING DYNAMO FIELD CONNECTIONS.

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displaced by an ammeter in the work circuit, as he himself suggests. Even if series incandescent lamps are used there is no reason for using a voltmeter to indicate




SERIES STREET LIGHTING CIRCUIT.

the condition of the circuit, but if it were desirable, the simplest means would be to connect one in shunt relation to a lamp in the work circuit, located on the switchboard.

CECIL P. POOLE.

New York, N. Y.

## Two More Electrical Paradoxes.

*To the Editor of American Electrician:*

Judging from the number of solutions, both correct and incorrect, which were offered in your last issue to the problem of the electrical paradox of Mr. Blake, perhaps some of your readers will be interested in showing (or trying to show) how currents would flow under the following conditions:

In Fig. 1 there are two independent circuits connected together at one point, as shown, by a thick copper block a. In this block there will then be two parallel cur-

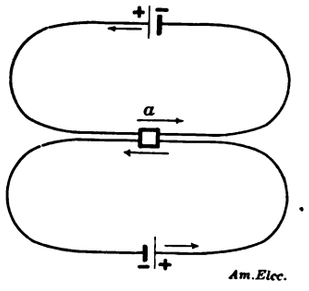



FIG. 1.—SMALL RESISTANCE IN CIRCUIT.

rents flowing in opposite directions, and they will therefore not be obeying the laws which govern them and which forbid this.

Now suppose this copper block to be replaced by a long, thin wire R of considerable resistance, as in Fig. 2; what will the currents do then? It will be noticed that the drop in volts in the portions of the circuits which they have in common will be in two opposite directions—that is, of opposite algebraic sign—and that is what causes the difficulties.

I would advise those who think they have solved it to test their solution by applying it to the case in which one current is small and the other is large; also when one voltage is low and the other high; also when one is an alternating and the other a direct current.

Here is another paradox. If a hollow non-conducting ring be filled with an elec-

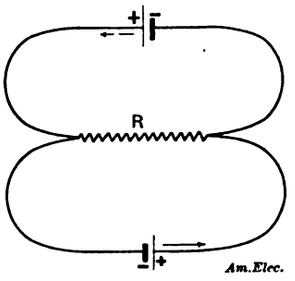



FIG. 2.—LARGE RESISTANCE IN CIRCUIT.

trolyte and placed around a magnet in which a current is being started, an induced current will then flow in the electrolyte, but there will be no decomposition. This is contrary to the laws of electrolytes, but nevertheless it will happen.

Here is another. If an alternator be excited by an alternating current it is well known that the frequency of the current which is generated will be doubled. It then must follow that if an alternator is made to excite itself an infinite frequency will be produced.

S. T. LAIRD.

Chicago, Ill.

## An Electrical Paradox.

*To the Editor of American Electrician:*

Sir—The electrical paradox propounded by Mr. Blake, in the November number, when fully investigated develops some relations that probably are not very generally understood.

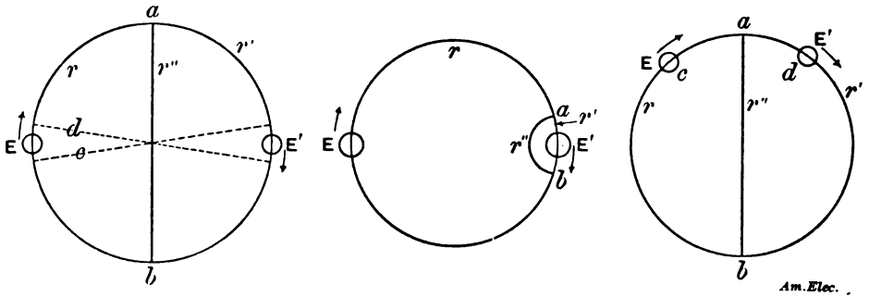
Mr. Gibson's answer in the January number shows the relation between the currents in the different parts of the system of circuits, but the investigation is not carried far enough, and, moreover, the statement in the last sentence is liable to mislead, as it implies that an e.m.f. cannot be applied between the points A, B in a direction opposite to that of the current flowing under the influence of the e.m.f. E, and such an assumption is not correct since the e.m.f between these points can act in either direction.

By changing the diagram to the form shown in Fig. 1, the action of the e.m.fs. can be more readily understood.

In this diagram, let E be the principal, e.m.f. acting in the direction of the arrow. Let E′ be the secondary e.m.f.; that is, the one that is to oppose the flow of current from *b* to *a*. Let r be the total resistance from *a* to *b*, through left portion of the diagram, and let r′ be the total resistance of the right hand portions from a to b, while r″ represents the direct resistance between *a* and *b*. The difference of potential between a and b is e, and the several currents are I, i and i′.

If E′ acts in the direction indicated by the arrow, the two e.m.fs. E and E′ will act in the same direction through r″, and if E′ is reversed, they will be in opposition in r″, hence an equation can be developed that will give the current through r″, in magnitude and direction by simply introducing E′ with the proper sign.

If E′ acts in the direction shown, and can impress upon the points a b, the same difference of potential as the e.m.f. E, then all the current induced by both e.m.fs. will flow through r″ from a to b. If E′ is sufficiently weak, E will force a current through r′ from *a* to *b*, but if E′ is sufficiently strong it can force a current through r from a to b.




FIGS. 1, 2 AND 3.—DIAGRAMS SHOWING FLOW OF CURRENTS.

If E′ acts in a direction opposite to that indicated by the arrow, the current in r′ will be in the same direction as in r, but it is not perfectly clear what the direction will be through r″, for if E is great enough, the current will flow downward from a to b, but if E′ is sufficiently strong, the flow can be upward, from *b* to *a*.

The direction of the current in r″ will depend upon the potential of a and b, and to determine this much we must know the strength of the currents I, i and i′.

From the diagram we can see that

$$I = (\pm i) + i' \ldots . \quad (1)$$

i being negative when flowing toward a.

The current i′ is:

$$i' = \frac{E - r}{r''} \ldots\ldots\ldots (2)$$

and since rI = difference of potential between a and b, through E.

$$e = E - rI \ldots . \quad (3)$$

For the current in r′ we have

$$= \frac{E - rI \pm E'}{r'} \ldots\ldots\ldots (4)$$

By substituting in (1) the values of i and i′, in (2) and (3) we get

$$I = \frac{E - rI \pm E'}{r'} + \frac{E - rI}{r} \ldots\ldots\ldots (5)$$

which by reduction becomes

$$I = \frac{(r'' + r')E \pm r''E'}{r''r' + r''r + r'r} \ldots\ldots\ldots (6)$$

By substituting this value of I in (2) we can get the current i′ flowing through r″.

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From an examination of equation (5) we can discover some important relations:

If $E = E'$, and $E'$ is negative, the equation reduces to

$$I = \frac{rI}{r'} + \frac{E - rI}{r''}$$

from which we get by reduction

$$I = \frac{E}{r' + r + \frac{r'r}{r}} = \frac{r'E}{r''r' + r''r + r'r}$$

and if $r = r'$, then

$$I = \frac{E}{2r'' + r}$$

In this case the currents I and i will be $i = i' - I$.

If $E = E'$ and $E'$ is positive; that is, directs a current toward b, then equation (5) becomes

$$I = \frac{2E - rI}{r'} + \frac{E - rI}{r''}$$

which reduced is

$$\frac{(2r'' + r')E}{r''r' + r''r + r'r}$$

and if $r = r'$ we can multiply both sides of the last equation by r and obtain

$$rI = \frac{(2r'' + r')E}{2r'' + r'} E$$

hence, since $rI = r'$, then the e.m.f *e* acting have: $e = o$.

From this we see that if E and E' are equal and in the same direction in the circuit r r' and $r = r'$, then the e.m.f. *e* acting between a and b will be zero, hence no current will flow through r''.

This condition is illustrated diagramatically in Fig. 2, in which E and E' act in the same direction in the circuit r r' — and $E = E' - r = r'$. Under these conditions the current impelled by E, tends to enter r'' through a with the same force as the current impelled by E' tends to enter through b, hence the two actions balance and the current in r'' is zero. So long as $r = r''$ and $E = E'$, the current r'' will be zero regardless of the position of a b, or of the magnitude of the resistance r''. If a b is moved anywhere from position c to d the current through it will remain zero even if the resistance of r'' is infinitesimal.

If the two e.m.fs. are not equal, points *a b*, between which no current will flow can be found, and these will be where

$$\frac{E}{r} = \frac{E'}{r'}$$

for then we will have $I = i$; hence

$$i' = I - i = o.$$

In Fig. 3, if E' and r' are very small, and E and r are very large, their relation can still be such that

$$\frac{E}{r} = \frac{E'}{r'}$$

and if so, there will be no current through r''.

If $\frac{E'}{r'}$ is greater than $\frac{E}{r}$, then i will be greater than I, and i' will have a value, and since this value is equal to the excess of i over I, the direction of i' will be from b to a. If $\frac{E'}{r'}$ is smaller than $\frac{E}{r}$, I will be greater than i, and i' will flow from a to b,

If the two e.m.fs. do not divide the circuit resistance equally; that is, if in Fig. 4 the resistance c a d is less than c b d, the points a b, between which no current will flow, must divide the sum of the two resistances equally, if $E = E'$, and proportionately if E is greater than E' or E smaller than E'.

To summarize, if two e.m.fs. act in the same direction in the circuit, either e.m.f. can be shunted and no current will flow in the shunt if the shunted e.m.f. divided by the shunted resistance is equal to the other e.m.f. divided by the remaining resistance. If the two quotients are not equal, then a current will flow through the shunt, and its direction will be opposite to that due to the e.m.f. giving the smallest quotient, and this is true regardless of the resistance of the shunt.

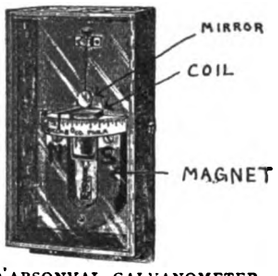
WM. BAXTER, JR.

Jersey City, N. J.

## Electrical Catechism

*270. How are instruments affected by outside magnetic influences?*

All instruments depending upon the magnetic effect of the current are more or less sensitive to outside magnetic fields, for these either weaken or strengthen the magnetic field inside the instrument. Generally speaking, the weaker the regular magnetic field the more easily it is affected by outside disturbances. Delicate galvanometers, which depend upon the earth's magnetic field, are sometimes sensitive to the running of a dynamo hundreds of feet distant or to the return currents from a trolley car some thousand feet distant. Almost every instrument is affected if close to a dynamo or a motor. Instruments having permanent magnets are liable to affect one another unless kept at least 2 ft. apart. The magnetic field around conductors carrying heavy currents is strong enough to affect instruments of the electro-dynamometer type, and sometimes even those of the d'Arsonval (see No. 233, "American Electrician," August, 1898, page 391) type. In no case should instruments be placed within two or three feet of a dynamo or a motor.




D'ARSONVAL GALVANOMETER.

*271 How can one tell whether an instrument is being affected by a stray magnetic field?*

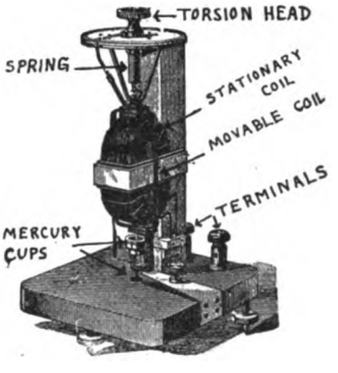
By turning the instrument around, the effect of the outside disturbing field will be reversed, so that if the reading was too high before, it will then be too low. The average of the two readings taken with the instrument in two positions will be close to the correct reading. If the instrument does not depend upon the field of a permanent magnet, its readings may be corrected by simply reversing the current through the instrument, instead of reversing the instrument itself.

*273. Are instruments measuring alternating currents affected by stray fields?*

That depends upon the nature of the disturbance. If the outside field is uniform in strength and direction, it will not ordinarily affect the readings of an instrument measuring alternating currents. But if the outside field is due to or is affected by the alternating current, it may affect the instrument. An instrument for measuring alternating currents is liable to be affected by the field due to the current in the wires leading to and from the instrument. Such instruments are liable to be affected by eddy currents induced in any solid masses of metal that may be near the coils. Any pieces of iron near the instruments are liable to become more or less magnetized by the current, which will result in strengthening the magnetic field in the instrument itself.

*274. Do instruments calibrated for use with alternating currents give correct readings when used with direct currents?*

Instruments of the electro-dynamometer type give equally correct readings with direct or alternating currents, except that they are more liable to be affected by outside magnetic disturbances when used with direct currents. Instruments having iron cores or needles give higher readings with direct than with alternating currents; with alternating currents, the higher the number of alternations the lower the reading. Electro-dynamometers are independent of the frequency. The type shown in the illustration has been improved upon in modern instruments.




SIEMENS ELECTRO-DYNAMOMETER.

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# Queries and Answers

**What horse-power is required for a 9.6-amp. arc lamp? W. J. L.**

One lamp of the given rating to the horse power.

**Is it necessary to have a starting rheostat for a 50-h.p., 2080-volt induction motor, or is the sliding resistance on the shaft sufficient? H. T.**

The resistance mentioned is designed to be sufficient.

**What size of storage battery would be required to run two 8-c.p. 10-volt lamps for twelve hours? J. S.**

Five 70-ampere hour cells, since each lamp will take about 2.8 amperes, and each cell will give 2 volts.

**How is polarity testing paper made? H. T.**

Saturate filter paper with a solution of ten parts of distilled water and one part of iodide of potassium. The positive pole is indicated by a brown mark on the paper.

**As a telephone current does not pass through zero, can it be called an alternating current? R. W. W.**

Broadly speaking, yes, since it is continually alternating in value and direction. Usually, however, the term is applied to a current having uniform cycles of variation.

**Should the exciting current necessarily flow through the coils of an alternator, as indicated by arrows on the same? H. T.**

Not so far as the action of the machine is concerned, but as the machine is tested and connected to conform to the direction indicated, it should not be changed.

**What will be the effect of running a motor whose power factor is .50 on a line, the cosine of whose angle of lag is .60? W. N. C.**

The amount of the increase of the angle of lag will depend entirely upon the relative magnitude of the motor inductance and the previous inductance of the line and its load.

**What is a potassium amalgam cell, and the value of its e.m.f.? J. L. T.**

Potassium amalgam (mercury alloy of potassium) contained in a porous cup immersed in dilute sulphuric acid in which is a peroxide of lead element. The e.m.f. is 3.525 volts, but the cell has never gone beyond the laboratory stage.

**What would be the result if one or two wires of a 10,000-volt three-phase circuit were to come into contact with the trolley wire of a 500-volt street railway circuit? J. R. B.**

If the three-phase circuit were properly insulated, there would be no effect if one wire came into contact with the trolley wire; if two of the three-phase wires came into contact, the trolley wire between would be promptly melted in any case.

**What is the best excitant for a silver chloride cell? J. L. T.**

Warren de la Rue, who first made this cell, used a solution of 2-3 of an ounce of sal ammonia to a quart of distilled water; if made stronger, it will dissolve the silver. Caustic potash may also be used, in the proportion of three parts of potash to four of water.

**If a lighting generator and its circuits are insulated from the ground, is there any tendency of the current to reach the earth? C. J.**

No, but if the system becomes grounded at a single point, there is a strain everywhere between the earth and the system. It is for this reason, and not from any natural tendency of current to seek the earth, that "grounds" have to be carefully guarded against.

**Is it safe to connect in parallel a transformer of 15-kw. with one of 5-kw., both being of the same make? G. W.**

All transformers having the same regulation may be successfully connected in parallel, but if two transformers having different regulations are so connected, the one having the better regulation will take an undue share of the load. Should this one be the smaller, there will be trouble.

**Does an alternating current possess any static properties? C. J.**

Any body will have a static charge with respect to another body insulated from it if they are at different potentials. If this potential is variable, the charge will also be variable, the value at any instant depending upon the difference in potential, capacity of insulated body, its distance and nature of the intervening medium.

**What is a rule for determining the width of a belt? O. A.**

It is best to obtain the size of a belt from a manufacturer's list. One formula is as follows:

$$\text{width} = \frac{K \times HP}{D \times V}$$

Where H P = horse power; D = diameter of pulley in inches; V = speed of belt in feet per minute; K = 38,000 for single belting and 24,000 for double belting.

**What amount of electricity may be produced by a given consumption of coal? R. N. P.**

The quantity of electrical energy that may be obtained from a given amount of fuel depends upon the quality of the coal, the efficiency of the boiler, engine, dynamo and distributing system, and the character of the load curve. In an ideal case, a kilowatt-hour may be delivered on three pounds of coal. In some cases a consumption of twelve pounds and over has been reported.

**I have an electric heater in series with four lamps on an electric railway circuit, the coil consisting of 40 ft. of car-heating wire, but it will not heat appreciably. What is the matter? F. B.**

Since it displaces one lamp, if the other lamps burn normally, it merely gives out the same amount of heat as the lamp displaced. Of the energy supplied to an incandescent lamp, 97 per cent is directly transformed into heat and the other 3 per cent into light, and finally also into heat. An electric lamp is therefore as much of an electric heater as one made of resistance wire and using the same watts.

**What are the data of a 6-in. induction coil? J. V. L.**

If made after the instructions in the January, 1897, issue, the core may be 18 ins. long by 1¼ ins. diameter. Use 6 lbs. of No. 36 wire on the secondary, and a single turn of No. 16 wire on the primary. The current will be fixed by the heating of core and length of spark, and must be experimentally determined. If connected to a direct-current lighting circuit, place incandescent lamps in parallel until the required current is obtained.

**How should electromagnets be connected for quick working—in series or in parallel? N. T. S.**

That depends upon the resistance of the external circuit. When the resistance of one of the spools is greater than that of the external circuit, the spools should be connected in series; or in parallel if such resistance is less than that of the external circuit. The law applying to the connection of magnets in circuit is, when inductance is considered, precisely similar to the law for connecting batteries in parallel or series.

**Are any devices in use to prevent inductive cross talk on telephone lines? R. S. H.**

No device can restore to or subtract from the receiving voltage, the voltages that inductive action has added to or subtracted from the transmitting voltage. By properly arranged line transpositions, however, inductive action in one section may be neutralized by the oppositely acting inductive action in an adjacent section. The transposition causes cross-talk voltage in one section to be opposite to that in another section, therefore neutralizing each other.

**Knowing the power factor of a motor, as given by the manufacturer, how is the effect on the lag angle of the line determined? W. N. C.**

Knowing the resistance and the power factor of the motor, its inductance may be determined. Knowing the resistance and lag angle of the line, its inductance may similarly be determined. Lay down a right-angled triangle whose base is the sum of the two inductances, and whose perpendicular is the ohmic resistance of the line, neglecting the resistance of the motor. Then the angle between the perpendicular and hypotenuse is the resultant line lag angle.

**In speaking of line loss, is it meant that there is a loss in both voltage and current? R. M. K.**

In voltage alone, the loss in volts being the e.m.f. required to force the given current through the circuit resistance. In the case of alternating currents and inductive circuits, there is an additional drop, being the e.m.f. required to overcome the counter e.m.f. of inductance. The first-mentioned drop involves a direct loss of energy due to the whole current passing, while inductive drop only involves an energy loss due to the so-called idle current, which is additional to the energy current.

**I have made a solenoid, using 2000 ft. of No. 22 wire and a core 2 ins. in diameter, which draws a weight of 25 lbs. when connected to a 110-volt circuit. What change should be made to bring the capacity up to 60 lbs.? O. F.**

A larger core, balanced, might improve the working, but as the ampere-turns are arleady more than sufficient for a 150-light dynamo, this is doubtful if the pull is exerted over a considerable distance. A solenoid is a very poor appliance for the transformation of electrical energy into mechanical work. A shuttle-core, with small clearance, in a bi-polar field is better, using a pulley on the shuttle shaft to multiply the motion. Best of all, is a motor suitably geared or belted.

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## BIOGRAPHY OF AN ARC LAMP CARBON.

The most essential factors in arc lamps are the carbon pencils, from the consumption of which the light is produced—not, as is sometimes thought, from the arc itself, but almost entirely from the glowing ends—but very few people who use them, or who note the unburned stubs that are thrown in the street by the lamp trimmers, have any definite idea of what material or how they are made. To supply this information is the object of this story.

At the outset it must be noted that there are various grades of carbon pencils produced for lighting purposes, and until recently the high-grade carbons employed in enclosed arc lamps have been mostly imported, and have for a long time been regarded as superior to any product in this country.

This is a doubtful claim, however, for the works which turn out the carbons which we are to describe are now competing successfully with the reputed high-grade products of the old country. These works are located at Washington, Pa., thirty miles from Pittsburgh, and are owned and operated by the Washington Carbon Company. They really embrace two factories, in one of which carbons are made by the moulding process, and in the other by the forcing process.

The material from which the ordinary carbons are made is a kind of coke, the residuum of petroleum oil stills, and is purchased directly from oil refineries. It is a porous black material, a little darker than ordinary coke, and has about half the specific gravity of the latter. The high-grade carbons, however, such as compete with the imported article, are made from lampblack, or what is known as lamp-black carbon, and is produced by the burning of coal tar in suitable chambers.

In preparing the coke in the Washington factory it is first ground in a bark mill to pea size, and is then elevated by belt conveyers to large storage bins on the second floor. It is next calcined by being placed in fire-brick furnaces or retorts which, on being filled with the material, are fired by the consumption of natural gas, the fuel being first introduced through suitable burners, entering the front wall. Air is excluded, so that the material burns in its own gas, and by this process all the volatile matter is driven off, leaving a mass of ninety-nine per cent pure carbon. When removed, it is allowed to cool, and is then again elevated and ground in an ordinary burr stone mill to a fine flour, and is bolted through a silk cloth into four grades.

The next process consists in incorporating with the carbon a binding material, which is a product of coal tar distillation. This binding material is first ground to a fine powder, when it is combined with the carbon powder in certain proportions, and then the mass placed in a revolving heater or mixer, in which the materials are thoroughly combined under a temperature of about 200 degs. When cool it is again ground in what is known as a centrifugal mill, consisting of two discs set edgeways, and which are revolved in opposite directions. It is thus reduced to a fine powder, and again bolted in revolving sieves, when it is ready for the moulding process.

The moulds are of metal, made in two parts, and contain from twelve to eighteen grooves, depending upon the diameter of the pencils to be formed. These are kept hot by means of natural gas jets kept burning under the grated surface of the moulding tables. Each moulder carefully weighs out sufficient material to fill all the grooves, and when filled the mass is smoothed off with a straight-edge, and the upper half of the mould is placed on top of the powder, being slightly pressed down by hand. It is now carried by means of endless conveyors in the direction of two hydraulic presses, located at the end of the conveyor. There are three of these endless conveyors, which are about 18 ins. wide, 70 ft. in length, and are placed not far apart in parallel lines. The middle conveyor travels in an opposite direction from the others, and twice as fast.

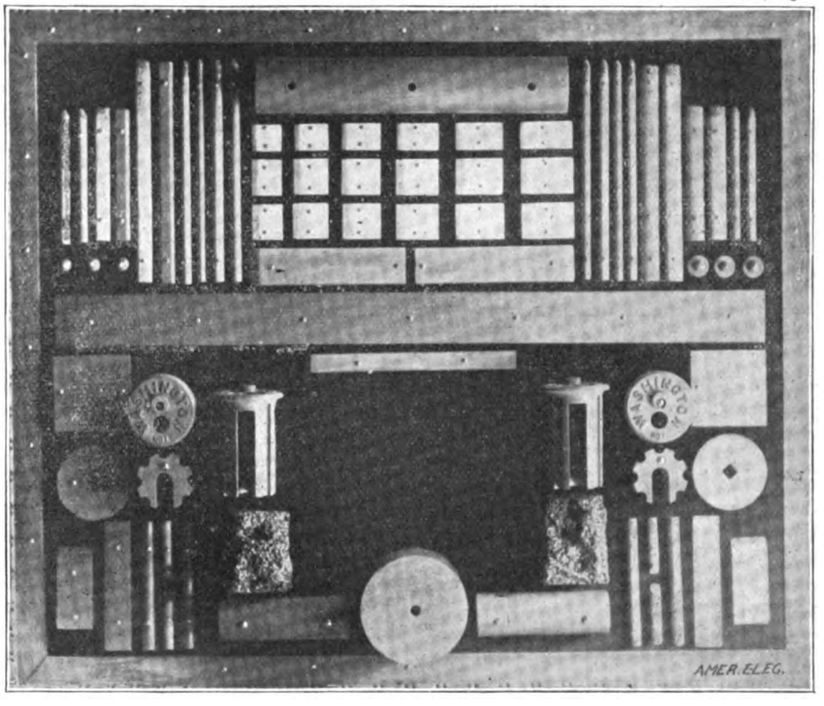
The moulders occupy booths or pockets in each side of the conveyors, and when the moulds are filled they place them on the one running in the direction of the presses, while the other two serve to bring back the moulds after the press has done its work.

As the moulds reach the presses, attendants slide them to the right or left upon the plungers of the presses, which are about 13 ins. in diameter. By means of a foot lever the plunger is lifted and the two parts of the moulds are subjected to a pressure of about 350 tons as indicated by a gage, and is automatically cut off as soon as the requisite pressure is obtained. The attendants then place the moulds with their contents upon the returning conveyor, and the moulders take them off in turn and remove the pencils, which are held together by a thin web of material. The moulds, still hot, are then greased and again filled.

The pencils on being removed are placed on racks and taken to a dressing table, where they are broken apart by a wedge-shaped tool that is hit with a light hammer. The pencils are then fed by hand into a stripping machine, in which they are drawn by power between the edges of two steel discs about 6 ins. in diameter set at an angle to each other, which process serves to shave off the remaining portions of the web, so that the entire surface of the pencil is made true and perfect. The pencils are then packed in trays and are made ready for the baking or firing process.

For baking there are twenty-one furnaces employed in the first factory, each having a capacity for receiving from 60,000 to 100,000 carbons. These furnaces are made of fire-brick, and have a sectional arched covering, which is removed for filling or cleaning. In charging the furnaces, the carbons are carefully piled in layers to the depth of 4 ft., with a thin course of black sand between each layer. When filled, the furnaces are closed by replacing the arch section and are fired by means of natural gas, the walls being so constructed that the heat passes entirely around the mass of carbon. It requires about three weeks for suitable baking of a batch of carbons, which includes the time consumed in charging the furnaces and allowing for the cooling of the contents.

By means of forms the carbons are removed from the furnaces and taken to the sorting room, where the "crooks" are separated from the straight pencils. The "crooks" are detected by allowing the carbons to roll, one at a time, down on the face of an inclined metal plate, set at such an angle to the eye of the operator that he readily detects any unevenness by the light




A VARIETY OF CARBON PRODUCTS.

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rays which appear underneath. The "crooks" are not all scrapped, however, but are cut up for making short carbons, the ordinary lengths being from 12 ins. to 14 ins.

The copper plating process follows, in which the carbons are suspended from copper bars by being attached with plating snaps, and immersed in the copper-plating solution, about 400 pencils being placed in each vat. The process requires about twenty minutes, and the plating current is produced by two generators, one having a capacity of 800 and the other of 500 amps. The carbons are then placed on drying racks, after which they are packed in boxes, containing from 500 to 1000, and are ready for shipment.

There are two processes employed in forming the carbons, one the moulding process described above, and the other known as the forcing process. In this later process the material is prepared and mixed as above described, when it is pressed by hydraulic power into cylindrical forms about 6 ins. in diameter and 6 ins. in length. A number of these billets are then placed end to end in the chamber of large horizontal hydraulic presses, of which there are four. Power is then applied to the charge with a pressure of about 250 tons, which



ARC CARBON MOLD.

serves to force the material in a continuous rod through discs at the outer end of the cylinder, the size depending on the diameter of the dies employed. The rods are then cut up into suitable lengths, and are fired as described for the moulded carbons, when they are pointed on an emery wheel. The cored carbons are also made on these machines, a small round rod being placed in the middle of the die, which delivers the carbon in the form of a tube. These are then filled with a material softer than the body of the tube, and are designed for use with alternating and direct current lamps on incandescent circuits. In this department carbons for enclosed arc lamps are also made, but by a process which is kept a trade secret.

The output of the works, however, is not confined exclusively to arc light pencils, but includes brushes for generator and motor service, carbons for primary batteries, and large carbons up to four or more inches in diameter, for use in electric ore reduction works and electrolytic processes.

The success obtained in producing durable high-grade carbons is largely due to the careful tests to which the crude material and samples from the finished products are subjected. It is the practice to chemically test samples from every lot of the crude material when received, and in addition samples from the contents of each furnace are thoroughly tested, both for light, efficiency and for resistance. For these purposes a testing department is established, which occupies the second floor of the office building adjoining the works. Here are provided arc lamps of various types, some of which are located in cupboards lined with asbestos, having in the doors plates of colored glass, for determining the durability and character of the light ray, and screens or graduated sheets, for measuring the length of the arc, which is reflected through suitable lens provided for the purpose.

## HOW TELEPHONES ARE MADE.

While commercial telephones have about the same number of parts and general characteristics, still they may differ widely in the method of manufacture, and adjustment of various parts, so that when one is informed as to the methods followed in a certain telephone manufacturing establishment, he is not sure that he knows all that there is to be known in the science of telephone construction.

To add to the fund of knowledge regarding telephone making, this article details some of the shop practices, as found in the works of the Hipwell Manufacturing Company, of Allegheny, Pa. The name of the company is comparatively new in the telephone field, and although the firm has been engaged for a long time in the manufacture of telephones for various jobbing companies, it has only recently put its own instruments directly on the market, which it now does, with a guarantee warranted by experience.

The works occupy a four-story brick building, 100 ft x 40 ft. at 100 North Avenue, but all this space is not by any means devoted to telephone manufacture, the principal output of the works being oil lamps of almost every description, including lamps of several of the well-known trade mark specialties, which the company manufacture in great quantities for firms who put them out under their own name. The equipment of the works is very complete, including stamping presses and metal working tools for shaping sheet metals and the wick adjusting mechanisms of many of the high-grade lamps. The lamps are made in every possible variety, from plain table lamps to the highly ornamental and artistic designs found in parlor and pier lamps.

It is, however, with the making of telephones that we have chiefly to deal, and in this department there is also a complete line of special machinery. For bending and tempering the generator magnets, there are two magazine feed furnaces, in which natural gas is employed for fuel, and which is considered superior to coal for such purposes, because it does not leave a scale on the surface of the metal heated. The bars, which are ⅜ x 1 in., are first cut into suitable lengths and are then fed endways into the opening of the firebrick furnace, each one pushing those ahead of it along as it is inserted.

After the bars have traveled a certain distance and they become suitably heated, they fall out to one side and are immediately placed by tongs in a hand bending machine and formed in horse shoe shape. Being formed, they are next passed to a second furnace and hang over a slanting rod on which they slide one against the other through the fire, when they are taken out at the end at a proper temperature, and tempered by being immersed in water, the very best steel that can be had being employed for magnet purposes. The furnaces have a capacity, should it be necessary, to bend and temper several thousand a day, while the capacity of the works is equal to about two hundred completed generators a day.

The work of forming the magnets is carried on in the basement of the building, while that of forming the more delicate parts, the winding of the armatures and assembling, is carried on on the upper floor. The machines include punches, lathes, screw machines, many of which are the company's own design and make, as well as are the dies and templates employed.

Following the magnets, we go to the grinding room, where by means of emery wheels the outer surfaces of the horseshoe forms are carefully ground and polished. From here they go to the nickel-plating department, and are thoroughly plated, for which purpose a number of large vats are employed, with a generator for supplying the plating current. They next go to the buffing room, from which they come out as bright as a looking glass, and are ready for magnetizing. This is done by placing them one at a time on the poles of a powerful electromagnet, drawing them back and forth, and turning them over endwise, until they are thoroughly magnetized. Three are usually placed side by side in each machine.

In the process of cutting the gears which revolve the armature, from fifteen to sixteen blanks are placed on an arbor and thoroughly clamped together, when the cutting tool is run across the face of the whole lot, and the teeth cut very rapidly. Hardened templates, dies and micrometer gages are provided for each of the workmen, so that like parts are made interchangeable and all to an accurate fit.

The armatures are cast with two poles, and for finishing up, they are inserted endwise in an arbor die, when the outer faces of the poles are turned to fit the contour of the die. They are then placed in a hollow mandrel, in which they fit accurately, and the journal bearings of the shaft are turned, being self-centered in the operation, the workmen not being required to make any measurements or adjustments.

For winding the fields a special power lathe is provided with an automatic register, which records the number of turns, and rings a signal when a coil is complete. For winding the coils of the receiver magnets, the register records the length of the wire employed, and the spindle of this machine is driven by means of a friction disc, which runs in contact with the face of the driving disc, the former being so mounted that it can be moved back and forth across the center of the driving disc, by which means the speed of the spool may be increased or diminished, or it can be reversed at the will of the operator, should it

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be necessary to unwind a lap that goes wrong. The armature cores before winding are covered with an insulating varnish.

A special feature of the telephone manufactured is a moisture-proof transmitter, in which the carbon granules are so housed that they are not exposed to moisture, and these transmitters are put up so that they can be carried about and new ones put in place of old ones at any time. The induction coil of the transmitter is made with heavier wire than is employed by most manufacturers, and the cores of the induction coil are made of a special grade of soft wire. The parts of the 'phones are assembled and mounted in cases of various patterns, including plain and ornamental designs, and of the leading varieties of wood usually employed for telephone cases.

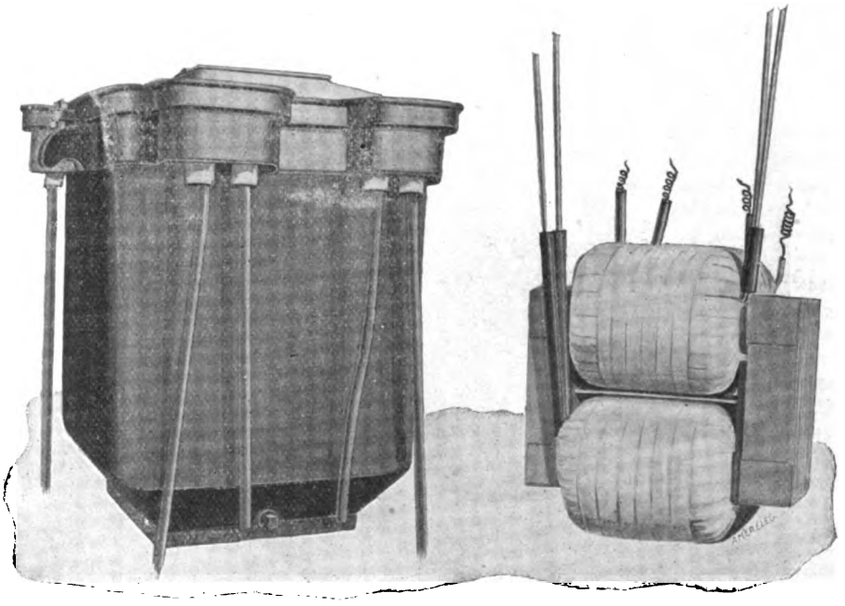
## THE MANUFACTURE OF STATIONARY TRANSFORMERS.

There is no class of electric apparatus that seems so simple in the arrangement and number of its parts as that designed for changing the voltage in circuits either for lighting, high tension transmission or other purposes and yet to produce an efficient transformer it is necessary to carefully proportion the relation of the windings of the primary and secondary coils, and it is of the highest importance that a grade of electrical sheet steel be employed which is uniform in quality and which will remain free from deterioration under any period of service, while, at the same time, the core must be carefully proportioned in its relation to the copper, so that the losses may be reduced to the minimum.

All these conditions, the manufacturers claim, have been met in the construction of what is known as the Type "K" transformer, which is now being manufactured by the Pittsburgh Transformer Company, of Pittsburgh, Pa. While this company is comparatively new, the principals, Mr. A. F. Harrold and Mr. F. C. Sutter, have been long engaged in the design and manufacture of transformers for one of the leading electrical manufacturing companies, and, furthermore, being in close touch with one of the large manufacturers of electrical sheet steel, they are able to obtain picked lots from which to make the cores, so they can guarantee all their output as being of the highest possible grade.

This type of transformer is manufactured in capacities ranging from .6 to 30 kw. In the design, as will be noted from the accompanying illustration, the core is of rectangular form, with the winding placed about the long sides. The core is built up of thin strips, known as No. 29 gage, and the quality is such that all spring tendency is eliminated from the metal, so that when bent it yields as limp as a piece of lead. The quality of this steel has heretofore been regarded, though highly desirable, as commercially impracticable. In the process of construction these plates are set up side by side; after the coils are placed over the long sides, the short sides are constructed by placing one end of every alternate strip between the plates on one side and letting it butt against the edge of the plates on the other side, so that the end plates are virtually dovetailed into each other.

In the construction of the coils, each of which contains a primary and a secondary winding, the secondary, generally of multiple strap, is wound upon a mould having the size and shape of the core. Over this is wrapped heavy mica plate reinforced by pressboards, and on this is then wound the primary. The primary is set in somewhat from the edge of the secondary, and is further protected by a collar of mica which completely incases the ends of the high tension winding. The mica plates alone used in this construction have a minimum breakdown strength of 20,000 volts, so that it will be seen that the company has taken the most rigid precautions regarding their insulation. The cores are heavily wrapped with pressed board and tape and the coils



TRANSFORMER CASE AND COILS.

then slipped over them, with b fibre plates, which wedge them closely to the core.

By bringing out to the line wires, the ends of the primary winding from the outside layers, repairs can be readily and easily made should the coil be damaged by lighting discharges, or static sparks, which very seldom penetrate more than a single layer of the windings.

The terminals of the primary and secondary coil are respectively brought out on opposite sides, the primary leads going to a terminal plate. They are then soldered to the leads, which pass out vertically downward through porcelain bushings. The coils being in place, the end sections of the core are then built up and both ends are capped with a spider, which fits the core and has arms which hold the transformer in place within the case.

In the large sizes the core with its coils is placed in horizontal position, but in the smaller sizes the coils are vertical. Being finished, the transformer is mounted in a cast-iron case, handsomely japanned, and is designed to be operated either dry or immersed in oil. The use of a high-grade of mineral oil is recommended, as by its use the insulation resistance is increased to a marked degree, while it tends to keep the parts at a lower and more equable temperature.

On being finished each transformer undergoes a thorough test, both for insulation, operation and for measurements of the iron and copper losses; for the former a 10,000-volt alternating current is employed, and it is estimated that a piece of apparatus that can stand these tests is assured of a long life. The containing case, as will be noted, is cast with lugs on the back with chambers designed for receiving the heads of bolts or lag screws, by means of which it is suspended in position. The transformers are all designed to safely carry overloads of 25 per cent for periods up to five hours, with a temperature rise of not over 45 degs. C. above the air.

For the protection of the transformer the company provide a porcelain single-pole primary fuse terminal. They also provide a tube terminal insulation, which prevents the oil from following up the leads by capillary attraction, thus protecting the rubber coating of the cables from softening.

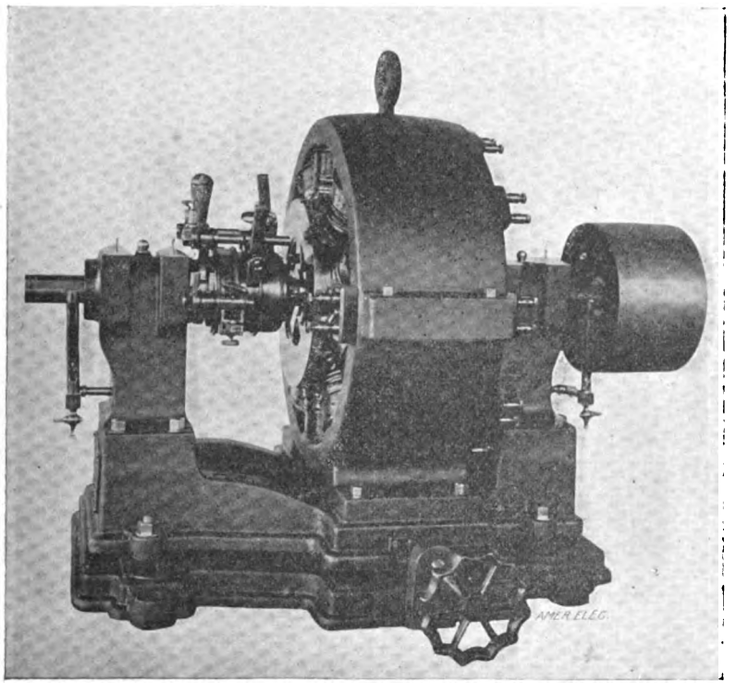
The works of the company are located in the Arrott Power Building, on Penn Avenue, and are well equipped for the manufacture and shipment of the product. The principal features of the shop are the winding lathes and shearing machines, all winding being as nearly automatic as possible. The company has adopted the method of preparing all transformer plates on these shearing machines, as much better work is possible than by the use of dies and punches. A testing outfit, consisting of a generator, designed to give a true sine wave, switchboards and instruments, makes the work of testing convenient and expeditious. Although on the market but a comparatively short time, the company has secured a liberal patronage, and has installed its apparatus in all parts of the country.

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# New Apparatus and Appliances

"IDEAL" ALTERNATOR.

The accompanying cut shows a type of "Ideal" alternator, of which a number have been built for experimental purposes for use in the laboratories of colleges and manufacturing works. Machines of this type are now in use in the laboratories of Stevens Institute, Georgia School of Technology, University of Wisconsin, Pennsylvania State College, Gale University, Drexel Institute, Alabama Polytechnic Institute and in the works of Queen & Co., Bristol Company, Ward Leonard Electric Company, Keystone Electrical Instrument Company, Hunter Fan & Motor Company, Lakon Company, Fleming-Spence Electric Company, Diamond Electric Company, Ironclad Resistance Company, Empire Elec. Instrument Company, Dupont Laboratory, and elsewhere.



IDEAL ALTERNATOR.

This alternator is designed to generate three-phase currents at 220 volts, and is therefore supplied with three collector rings, between any two of which it is possible to obtain a current of 13.3 amperes and 220 volts, when the armature is revolved at a speed of 720 revolutions per minute. Two additional pulleys are provided by means of which it is possible to drive the alternator at 600 revolutions per minute and 420 revolutions per minute, at which speeds the voltages are 180 and 100 respectively, the field excitation being maintained constant.

The field frame is a massive steel casting with ten poles. The ten field spools are connected in series, each consisting of 410 turns of No. 14 B. & S. wire, requiring a field current of 3 amperes at 100 volts to excite the field at full load. The armature is 10⅞ ins. in diameter, is of the tooth type and provided with 60 slots, each 11-32 in. wide and ⅞ in. deep.

The core is built up of discs of the best grade of soft sheet iron, and the winding, which is embedded in the slots, is well insulated from the core. The portion of the winding at the ends of the armature is protected from injury by two ornamental brass end shields, provided with openings of sufficient size to allow free circulation of air and ventilation.

The 60 slots above mentioned provide space for 30 coils, each of which consist of 21 turns of No. 12 B. & S. wire. These 30 coils on the armature are divided into three groups of 10 coils each, and the three groups are joined together in star fashion. The coils are connected around the armature in regular order to the first, second and third groups. The two halves of a coil are separated by two slots. When all the coils are connected to the three groups the three starting ends are soldered together and well insulated. The three finishing ends are brought to the three collector rings.

The bearings are of the self-oiling type, and the armature is so well balanced that there is no vibration, even when the machine is driven at the speed of 2500 revolutions per minute. For varying the degree of tension on the belt, a hand wheel and belt tightener are provided on a special sub-base furnished with the machine.

This company also builds larger alternators for single, two or three phase currents, and winds the armatures for any voltage up to 2000 volts. The fields are either separately excited or provided with a composite winding; the latter is excited by a portion of the total armature current, which is rectified by passing through a special commutator. By this means the field excitation is increased as the load increases, and by making the proper adjustments, any degree of compounding can be obtained. Machines are also built according to engineer's specifications.

F. A. LaRoche & Co., Thirteenth and Hudson Streets, New York, are the manufacturers.

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VOLTMETER AND GROUND DETECTOR.

We illustrate herewith a voltmeter and ground detector for switchboard use, which, as will be seen from the engravings, embodies a number of distinctive features.




FIG. 1.—VOLTMETER AND GROUND DETECTOR.

All contacts, connections, etc., are mounted on a separate slab of slate, which is located at the back of a switchboard. From this a rod passes to the front of the board and has attached to it the operating handle, which carries an indicating pointer over a suitably lettered dial plate. The parts of these switches are all indepenently capable of the finest adjustment before or after in place, by nuts and screws especially provided for the purpose.

The other main points in the design are clearly shown in the illustrations and need

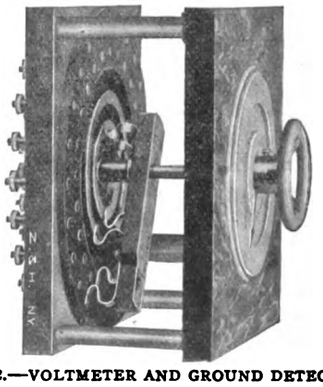


FIG. 2.—VOLTMETER AND GROUND DETECTOR.

no further comment. Great attention has been given to details, and, in contrast to many similar appliances of this class, these switches do not require constant tinkering to keep them in operating condition after they are installed.

The voltmeter switches are regularly made up to twenty circuits, and the differential galvanometer switches up to eight pairs of circuits. They are, however, made of greater range upon special order. The manufacturers are Zimdars & Hunt, 127 Fifth Avenue, New York.

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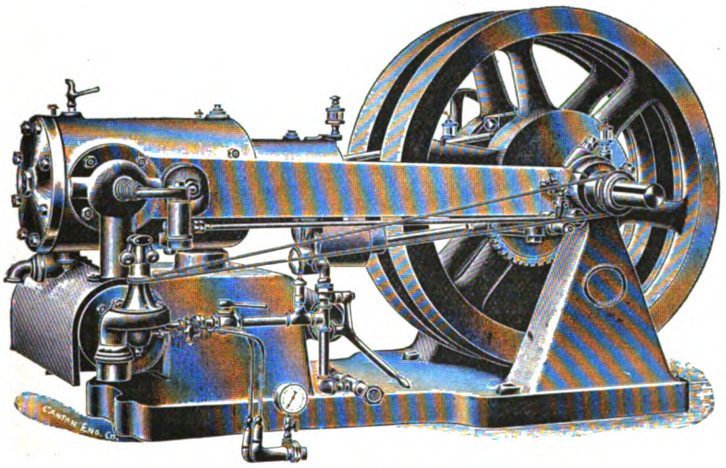
### THE PRIESTMAN OIL ENGINE.

Until comparatively recently, certain obstacles met with, prevented the successful operation of engines using safe oils. Through the ingenuity of scientific men, however, these obstacles have now been overcome and the success of the safety oil engine is an accomplished fact.

The Aultman Company, of Canton, Ohio, have recently taken up the manufacture of the Priestman Safety Oil Engine, which, aside from the character of fuel used, differs from gas and gasoline engines in several important respects.

For fuel is employed high test, safe petroleum, such as is used in common house lamps, and generally known as kerosene or carbon oil.

The following is the mehod of operation: A fine kerosene spray is injected into the chamber shown directly underneath the cylinder head. Here this spray is mixed with the proper proportion of air, for supporting combustion, and the mixture heated by the hot exhaust gases, which are made to pass through an annular space surrounding this mixing chamber before being expelled into the atmosphere. The heated charge of oil spray and air is then drawn through the inlet valve into the cylinder by an outward stroke of the piston. The inlet valve is not mechanically operated but is opened automatically by suction, or, in other words, the pressure of the atmosphere. The return stroke of the piston compresses the charge, which is then ignited by an electric spark from an ordinary battery, and the resulting expansion of the heated products of combustion drives forward the piston, thus imparting the energy which is utilized for doing work. During the succeeding stroke of the piston, the exhaust valve is held open mechanically, and the dead gases are swept out of the cylinder, which is thus prepared for the reception of a fresh charge of oil and air. The cycle of events just described embraces two revolutions of the fly wheels.



PRIESTMAN OIL ENGINE.

The chief departure from the gas engine principle of operation is in the treatment of the fuel, a considerable portion of which, if not all, is burned as a liquid spray instead of as a gas. This fact is evidenced in two ways.

Firstly, the proportion of air and of a gas must be very exact to give an explosive mixture—about ten volumes of air to one of gas. If this proportion is not closely adhered to in gas and gasoline engines, no explosions, or very weak ones will result. This generally accounts for the difficulty sometimes experienced in starting gas and gasoline engines. The proportion of air necessary for burning a given quantity of liquid oil is many times the latter, and need not be so exact to obtain an explosion. The Priestman engine is very easy to start and no trouble is experienced from this source, as almost any mixture of air and oil will ignite.

Secondly, a very small portion of the oil spray within the cylinder coats the walls of the latter and so perfectly lubricates them that no other means is ever provided for this purpose. This is a most distinctive and important feature, for no special cylinder oil is ever used, and no attention to this point is ever necessary.

By reason of the positiveness of the cylinder lubrication, the cooling water surrounding the cylinder can be allowed to boil without increasing the friction, and with beneficial results. It is only necessary to have sufficient water for keeping the cylinder jacket full. This feature is very advantageous with portable engines, and in localities where small water tanks are advisable.

The oil, which is kept in a tank—located wherever convenient—is pumped into the spray maker under a pressure of about 8 pounds. The oil consumption is about 1¼ pints per brake horse power per hour. Looking at the question of consumption in another way; every time an engine receives an impulse, it requires the burning of only about 1½ drops of oil to produce each horse power. This fact is a good illustration of the astonishing amount of energy that is stored in a minute quantity of oil.

The steam engine method of governing, that is, by throttling the charge, is employed and impulses are taken regularly whether the engine be running empty or fully loaded, each charge of oil spray being exactly proportioned to the load carried. The excellent speed regulation of the engine especially adapts it for electric lighting, and a steady incandescent light can be obtained without the use of counter shafting or extra balance wheels. It is an interesting fact, and one possibly not generally known, that by using a given quantity of oil in the Priestman engine for operating incandescent electric lights, more illumination can be secured than if the same quantity of oil were burned in a common house lamp.

It may be of interest to the reader to also know the actual amount of work that can be secured from a small quantity of kerosene burned in a Priestman engine that is operating some of the most common classes of machinery. Take electric lighting, for instance, one pint of kerosene will run eight 16 c.p. incandescent lights, or one 1600 c.p. arc light for one hour. When operating an ice machine, a pint of oil will produce about 200 pounds of ice at 15° F. from water at 70° F. If attached to a hoist, 100 tons can be lifted four feet, or one ton four hundred feet by one pint of oil; and when used for pumping, the expenditure of this small quantity of oil will raise 1000 gallons of water 96 feet high. In computing these figures due allowances have been made for the average inefficiencies of all apparatus employed.

As the Priestman engine is very simple in its method of operation, and is entirely automatic in its action, it is admirably suited for places where there is desired a cheap, safe, and reliable motive power, which can be satisfactorily handled by unskilled labor, and which demands the least attention.

The Aultman Company have recently added a number of improvements to the engine, amongst them being an air storage system, whereby engines can be easily started without recourse to any preliminary hand pumping or turning of the fly wheels.

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### POCKET BATTERY GAUGE.

The pocket battery gauge shown in the accompanying illustration, is of especial value to telephone inspectors and for use in testing telegraph and bell batteries and storage cells. The instrument is fitted in a case the size of an ordinary watch case, is dead beat in its indications, and easily attached to the cell to be tested. A special form is made for testing single cells of storage battery, in which use the indicator is of particular value, since with it may be detected a defective cell which, if left in circuit, might be ruined.




BATTERY GAUGE.

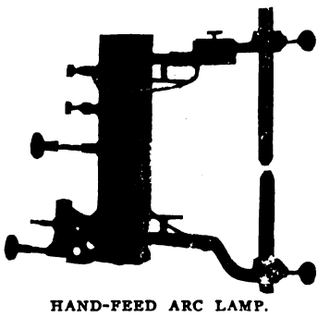
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The maker of the Warner pocket battery gauge described is the Standard Electric Time Co., Waterbury, Conn.

### HAND-FEED ARC LAMPS.

The arc lamp shown in the accompanying illustration is intended for stereopticons, moving picture machines, scientific lecture work, and other purposes rendering the use of a hand-feed lamp necessary or desirable.

The carbon holders are adjustable to any

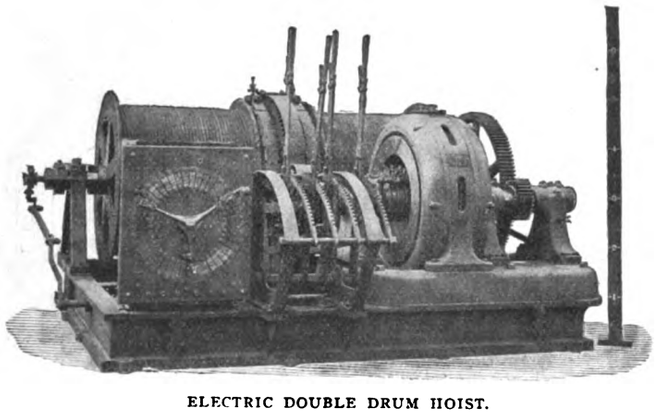


HAND-FEED ARC LAMP.

height independent of each other or the feed rod, and supplied with either plain or differential feed. As will be seen, there is no rack to get bent, and the feed rod is protected by being eased in a rectangular tube. Both carbon holders can be instantly returned to the starting position without the tedious operation of turning a feed screw backwards, as in the case of many other lamps. In regulating, but a slight movement of the feed handle is necessary, and then but once in every three to seven minutes, depending upon the size of carbon and the current used. The makers of the lamp described are Baker & Fox, 83 Schermerhorn Street, Brooklyn, N. Y.

### DOUBLE DRUM HOIST AND ELECTRIC MOTOR.

The electrical hoist, illustrated herewith, shows one of the recent applications of a General Electric induction motor to a double independent drum Lidgerwood mine hoist. It is compact in form, and the levers controlling the clutches and breaks and handle of rheostat are placed in the



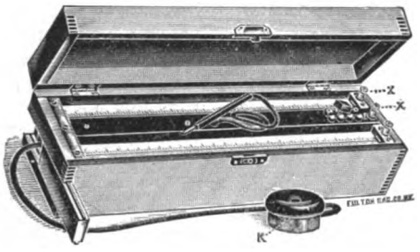
ELECTRIC DOUBLE DRUM HOIST.

position most convenient for control by the operator standing on a platform above the floor, and having a clear view over the top of the hoist.

Each friction drum is driven through a single-reduction gearing by a 100-volt 12-pole induction motor of 30-h.p. capacity, running at 600 r.p.m. Each drum is independent and is 42 ins. in diameter by 40 ins. face. Together they hold about 420 ft. of ⅞-in. rope. The maximum hoisting speed is 300 ft. per minute, and the weight hoisted, including load, car and cage, is 2100 lbs. The depth from which the load is to be hoisted is 400 ft. from the surface.

### DIRECT-READING OHMMETER.

In the accompanying illustration is shown the '99 type of direct reading ohmmeter, manufactured by the American Electric Specialty Company, 123 Liberty Street, New York City. This instrument differs from its predecessor in many important improvements. There are four scales lettered in four colors instead of three, whereby the range is increased from zero to over one megohm. The scale is engine-divided and its accuracy is thereby so increased that its makers do not hesi-



DIRECT-READING OHMMETER.

tate to guarantee an accuracy of minimum error to considerably less than ½ per cent. The stylus which formerly carried a battery key has now been made much stronger and lighter and the battery key has been placed in the telephone receiver where it can be conveniently manipulated by the other hand. The delicacy of touch is thereby largely enhanced. A special telephone receiver is used, which is constructed for great sensitiveness to any disturbing current rather than for its speech-reproducing qualities.

The brass work and other construction have also been materially improved. The containing box is now built up of strongly dove-tailed and glued joints, and shrinkage or expansion from moisture is an impossibility. The bottom of the box is removable and the batteries can be removed and replaced in a few moments at an extremely low cost, and it is not necessary to send the instrument back to the makers for this purpose. The batteries are very long lived and will last a year with daily constant use.

### ORGAN PUMPING OUTFIT.

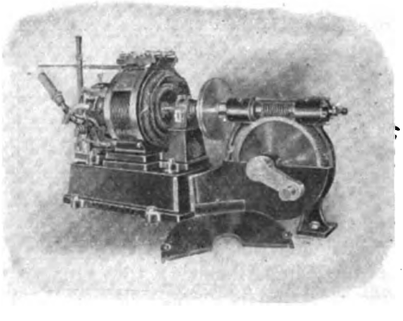
The need has long been felt for a reliable organ pumping outfit that can be operated by alternating currents, and recently such a combination has been placed on the market, as illustrated in the accompanying cut.

The outfit consists of a single-phase alternating current motor of 1 h.p., arranged with triple worm gear to directly transform the revolutions of the motor (1800 per minute) into the reciprocal crank motion required for an organ pump—45 strokes per minute.

In the system the motor is started and left running at a constant speed during an entire service or concert. The only disadvantage of this is the amount of current used while the pump is not in operation, and as this amounts to only 1 3/10 cents per hour with a rate of 10 cents per kw.-hour (power rates range from 5 to 20 cents per kw.-hour for this class of work) it will be seen to be an eligible factor, and in fact is fully compensated for by the absence of extra current incident to starting. Among the advantages are the absence of regulating rheostats and sparking of contacts on stopping and starting, and the simplicity and compactness of the outfit entailed.

The operation of this outfit is as follows: "The motor is started by the handle marked "Motor Starting Handle," and as the bellows of the organ is presumably empty, the friction clutch shown at the other end of the motor shaft is in contact with the worm disc and the motor begins pumping air into the air reservoir until filled. The natural rise of the top of the air reservoir to which the chain marked "connection to bellows" is attached through pulleys or bell-cranks, will release the friction disc at any desired point, and the pump mechanism will stop, leaving the motor running free, and thus taking almost no current.

As soon as the air reservoir begins to empty, the clutch operates again and as much or as little air is supplied as may be necessary to keep the reservoir charged with air. The action of the friction discs is positive and noiseless. The worm is of hardened steel. The worm wheel is run in a bath of oil and is therefore per-



ORGAN PUMPING OUTFIT.

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fectly lubricated at all times, and the entire outfit is designed and manufactured to stand hard and continuous service with little or no attention.

The action of the outfit may be controlled to pump fast or slow, and to change the speed as the air reservoir fills by merely making a spring connection between air reservoir and the motor instead of solid connection; the solid connection is advised whenever practicable, as there is then very little or no wear on the friction clutch.

The outfit described is manufactured by the Emerson Electric Manufacturing Company 714 St. Charles Street, St. Louis, Mo.

### NEW TYPE OF GENERATOR.

The new "Triumph" generator illustrated herewith is a multipolar machine which differs from the usual type in that the armature windings are divided into distinct and separate circuits connected through a special commutator to separate distributing circuits with a common return, as shown in the accompanying diagram. The initial voltage of each circuit is 220 volts. The current is generated in each circuit for only one-third of the time, or in other words, each coil on the armature is active for only one-third of a revolution, being entirely cut out of circuit for the remaining two-thirds. Actual test has demonstrated that when a rate of 5400 impulses per minute has been reached, the light is absolutely steady.

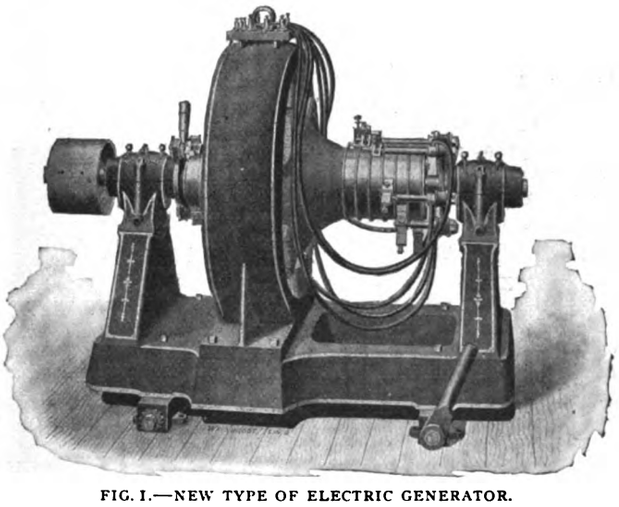


FIG. 1.—NEW TYPE OF ELECTRIC GENERATOR.

The manufacturers communicate to us the results of a recent test of a 300-light machine of this type, as follows:

Two new 16-c.p., 110-volt, 55-watt lamps were selected at random from a barrel of Buckeye lamps. and placed at each end of a Bunsen photometer. One was connected to the mains of a direct current machine and held at 115 volts, and the other connected with the dynamo being tested. The Bunsen disc was placed in the center of the scale and the current from the dynamo under test was regulated with a field rheostat until the lamp on that circuit was brought to the same candle power as that on the direct current. All readings were taken with a Weston portable voltmeter.

When the candle power of the lamp on the "interrupted current" generator was exactly the same as that on the direct current, the apparent voltage of the interrupted current was observed and the test began, the dynamo being belted to a countershaft, driven by a 12 x 14 automatic engine. Following are the results:

| | |
|---|---|
| Average of three cards, 33.35 h.p.; No. 16 c.p. lamps | 304 |
| Average of three cards, 24.43 h.p.; No. 16 c.p. lamps | 152 |
| Average of three cards, 13.82; fields open. | |
| No. 16 c.p. lamp, per h.p. delivered at full load. | 15.56 |
| No. 16. c.p. lamp, per h.p., delivered at half load | 14.32 |

It will be observed that these results are much better than claimed for any standard machine of the same capacity, and also that there is a surprisingly small drop in efficiency at half load.

As will be noticed from the photographic reproduction, the machine is simple and compact, and the manufacturers claim that the results obtained, while remarkable, can be demonstrated as theoretically possible from the principles embodied in the machine.

The manufacturers of this new type of machine are the Triumph Electric Company, Cincinnati, Ohio.

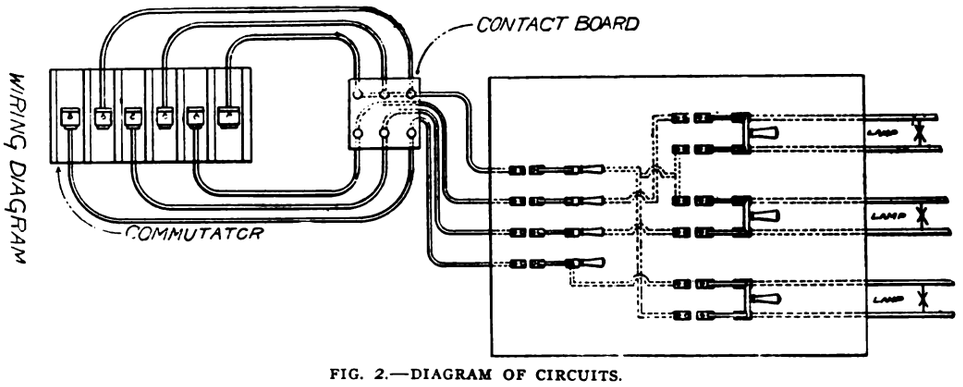



FIG. 2.—DIAGRAM OF CIRCUITS.

### INSULATING PAPER AND BOARD FROM ASBESTOS.

A product for insulating purposes and electrically indestructible, is now being manufactured by the Asbestos Insulating Company of Baltimore. The material is pure asbestos, so treated chemically as to remove all metallic particles, as well as other impurities, consisting of rock, lime and magnesia, which are found in the crude specimens. In the best Canadian specimens, the impurities removed amount to about 25 per cent of the bulk, leaving a base of two of the most indestructible factors found in nature.

The refined fibre is so improved by this process, that it can be employed in paper making, and spun into thread, which latter is used for insulating wire. Paper made from this material and rolled to eight one-thousandths of an in. thickness is stated to have a uniform resistance up to 1700 volts, and in blocks of an inch thick, made up of alternate layers of the paper, with thin rubber binding, and pressed to a solid mass, is equal to a resistance of 24,000 volts.

A desirable feature of this insulating material is, that it will not carbonize under any conditions, and cannot otherwise be affected by heat. The result of the purifying process gives virtually a new product, which is available for other than electrical purposes and should have a wide range in the arts, including fire-proof paints, and fire-proof material. On account of the extreme thinness of the sheet its use is claimed to reduce the size of armatures and other parts at least a third.

The process employed was the discovery of Mr. John F. Green, general manager of the company, who has given it a great deal of attention and experimented widely with samples of asbestos from almost all the regions where this material is found, up to as many as thirty-three different grades, many of the poorer grades being rendered commercially valuable by the process.

### AN ELECTRIC LIGHTER.

There has long been a demand for a practical electric lighter, which could be used on both electric light circuits and battery current. The type shown herewith, known as the "Matchless Electric Lighter," is made of the finest white china throughout, embodies these two essential points, and high efficiency, durability and economy are also claimed. The cost of maintenance is stated to be about one cent per month, and on electric light circuits no attention is required from one year's end to the other, save the moistening of the asbes-

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tos packing in the torch about twice a month with ordinary usage. An attachment plug and cord is furnished and can be inserted in any lamp socket or attached to the wiring direct as may be most convenient. The lighter is then at once available for use.

The cut represents the lighter especially adapted for use in smoking rooms, hotels, cigar stores, marine work, palace cars, apartment houses, office buildings, private residences, and in fact in all places where




ELECTRIC LIGHTER.

cleanliness and freedom from danger from discarded matches is desired.

The lighter is available where there is no electric light current, by merely connecting two cells of dry battery, which is stated to require renewal perhaps once a year, and often less. The coil, of course, never wears out. A hundred or more lighters may be connected to the same set of batteries, or to the same circuit, and whenever a residence is equipped with electric gas lighting appliances, the lighter can be connected directly to the wiring already installed, and will call for no more attention than would an additional burner on a chandelier. The manufacturers are Stanley & Patterson, 32 Frankfort Street, New York.

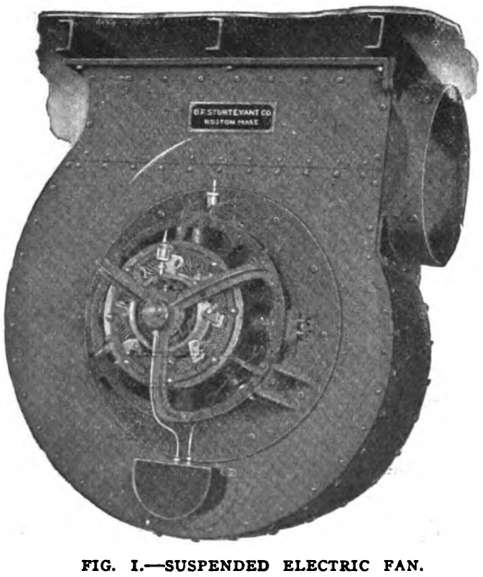


FIG. 1.—SUSPENDED ELECTRIC FAN.

### A SUSPENDED ELECTRIC FAN.

One of the prime advantages of an electric fan is its adjustability. Not only may it be located where most convenient for the adjustment of piping, but it may readily be constructed in such form as to be supported or suspended as may best suit the conditions. The accompanying illustration serves to make clear this point, for it represents an entirely new design built upon a special order by the B. F. Sturtevant Company, of Boston, Mass.

The fan as here shown was designed for use on shipboard, and is to be suspended from the deck. In general form the fan itself is of the usual steel plate construction, being an exhauster with its inlet upon the side furthest from the motor.

The motor itself is of entirely special construction, having eight poles, rendering it very compact, so that it extends the minimum distance from the side of the fan. In the size here shown the field ring was of wrought iron, although in larger sizes it is built of cast steel or cast iron.

The cast iron plate with projecting lugs, which is attached to the fan side, serves to center and hold in position the field ring of the motor, while tripod hangers extending from either side of this ring support the armature shaft in ring oiler boxes.

The field cores are of wrought iron, giving the highest efficiency in the field, and the pole shoes are of cast iron of such peculiar shape and size as to render the machine capable of extreme variation of load without sparking at brushes, and without any shifting or adjustment whatever. The field coils are machine wound, and thoroughly insulated, their form being thoroughly open. The windings present a maximum amount of radiating surface, which results in the most perfect ventilation, and prohibits any great accumulation of heat.

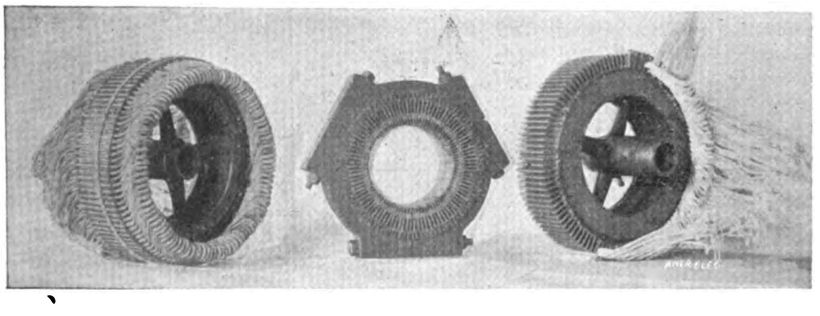
The armature cores are built up of laminated, slotted discs, mounted on a cast iron spider, having a hub projection for the reception of the commutator. These core discs are solidly clamped between two brass rings, which have corresponding core teeth.

The armature is of the coil wound drum type, and in the usual form has a two circuit winding, although in some cases multiple winding is used. This type of winding on machines of low speed and small output is of great advantage.

The commutator is of large diameter, and consists of pure rolled or drop forged copper segments, supported in a cast iron shell of spider construction, and thoroughly insulated. Reaction brushes of fiber graphite are used, and supported by special rigging.

These motors require no shifting of brushes from no load to full load, thereby greatly reducing the attention required.

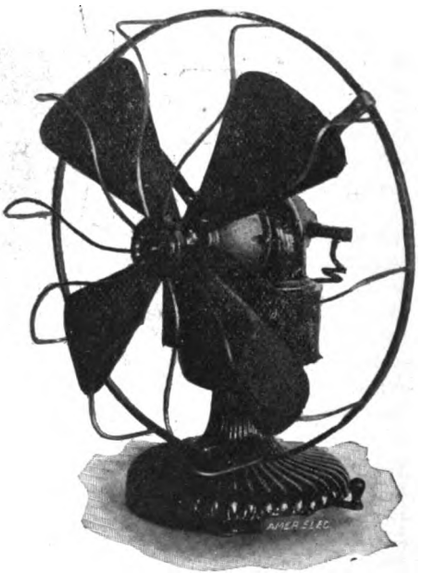
Evidently fans of this type can be constructed in various sizes and forms, and may be provided with motors having capacities ranging from three to 125 h.p.



FIGS. 2, 3 AND 4.—DETAILS OF ARMATURE.

### A NEW FAN MOTOR.

The fan motor shown herewith, known as the "Peerless," is among the first of the 1899 models to be gotten ready for the market. The type shown carries a 12-in. fan. When running at 1850 revolutions per minute it is claimed to absorb but 35 watts of electrical energy, or considerably less than that taken by a high efficiency 16-c.p. lamp. The construction of the motor is such that it is impossible for dust to gain access to it or the commutator. The makers are the Warren Electric & Specialty Company, Warren, Ohio.



PEERLESS FAN MOTOR.

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VICTOR TELEPHONE SWITCHBOARD.

The accompanying illustration gives a very good idea of the Victor metallic switchboard, being a reproduction of the photograph of an exhibit at the recent Northwestern Electrical Convention. One of the features of this board is that it has no conections on wood, all connections being mounted on rubber and soldered, thus obviating loose connection and cross talk. The simplicity of construction and fewness of parts of this board afford ample space for heavy installation and metallic parts, which tends to a double assurance of durability and high efficiency, with lowest cost of maintenance. The switchboard is built in five jack and drop sections, with entirely concealed wiring, tripolar single coil and low contact gravity drops, which, it is claimed, insure sensitive and positive action. The manufacturers of this switchboard claim that it is unrivalled in fewness, strength and simplicity of parts; in compactness, ease and rapidity of motion, and in durability and economy of maintenance. This apparatus is manufactured by the Victor Telephone Manufacturing Company, 166 to 174 S. Clinton Street, Chicago.



VICTOR TELEPHONE SWITCHBOARD.

## NEW BOOKS.

Twentieth Century Sketch Book for Schools, Colleges and Practical Men. Fifty leaves in block form. Woonsocket, R. I.: M. A. Avery. Price, 25 cents.

This convenience for engineers and draughtsmen consists of a block of sheets, each sheet having a marginal scale of inches. A sheet, therefore, has the advantage of sectional paper, without the disadvantage of sectional lines covering the object sketch. The size of the blank space surrounded by the marginal scale on four sides is 5 ins. x 8 ins. A similar sheet is made with the addition of an angle scale, which should be particularly useful in proving geometrical and trigonometrical calculations.

Fowler's Mechanical Engineer Pocket Book. Edited by William H. Fowler. Manchester, Eng.: Scientific Publishing Company. 324 pages, illustrated. Price, 1s. 8d.

This is an excellent manual of steam and mechanical engineering—in fact, comparing very favorably with the most pretentious hand-book on the same subject. The different sections have been prepared by competent engineers, and the data and other information appear to have been most judiciously selected. The section on electricity was prepared by Mr. H. A. Clark, of the Chelsea Polytechnic, and is an admirable collection of electrical engineering data and information having a direct practical bearing.

Hand-Book of the Corliss Steam Engines. By F. W. Shillitto, Jr. Bridgeport, Conn.: American Industrial Publishing Company. 197 pages, 54 illustrations. Price, $1.00.

This little book, embellished with a portrait of the author, purports to describe in a comprehensive manner the erection of engines, the adjustment of the Corliss valve gear, and the care and management of Corliss steam engines. While the information given can scarcely be termed comprehensive, it is yet clearly stated and eminently practical. The chapters on valve adjustment will be found particularly useful, and the same remark applies to a chapter on general repairs and management.

A Pocket Dictionary of Electrical Words, Terms and Phrases. By Edwin J. Houston, Ph. D. New York: American Technical Book Company. 945 pages. Price, $2.50.

In the preparation of this volume the author has not employed cross-references, but arranged the terms alphabetically in their natural order, thereby greatly enhancing the value of the book for ready reference. The definitions are concise, and the subject matter is up-to-date, all of the latest terms connected with polyphased currents being included. While not possessing the encyclopedic character of the author's larger dictionary, and though devoid of illustrations, the present work has the advantage of greater conciseness, more compact form and lower price.

Alternating Current Wiring and Distribution. By William Le Roy Emmet. Second edition, revised and extended. New York: The Electrical Engineer. 98 pages, 33 illustrations. Price, $1.

The second edition of this excellent little treatise has been thoroughly revised, and extended from 76 to 98 pages by the introduction of new matter. As a brief and concise exposition of the principles of alternating current working and their practical applications in distribution, this little book is of unusual value to both the engineer and the student. Those who desire to thoroughly understand the practical meaning of power factor, inductive load, reactance, etc., and to know how to apply the knowledge in actual cases, will find at present no other work to which they can refer with so much confidence.

Electrodynamics. The Direct-Current Motor. By Prof. C. A. Carns-Wilson. New York: Longmans, Green & Co. 298 pages, 71 illustrations. Price, $2.00.

The aim of this book is to apply the principles of electrodynamics to the electric motor, and the subject is very much simplified by the author's use of a so-called induction factor, or transformation of the fundamental equation applying in terms clearly showing the relation of the important factors, and enabling practical cases to be easily submitted to numerical calculation. The principles of shunt and series wound motors are developed, and chapters given on efficiency, acceleration, torque, control and armature reaction, special attention being paid to the street railway motor. An admirable feature of the book consists in the extensive use of numerical examples to illustrate the practical application of principles and formulas.

Twentieth Century Magic. The Construction of Modern Magical Apparatus, with the Introduction of New Experiments, Mechanical, Chemical and Electrical. New York: George Routledge & Sons. 160 pages, 100 illustrations. Price, $1.50.

Those seeking a means of amusing a company of friends, or even a public audience, will find in this book many ingenious methods, which, besides, have the advantage of being new. Chapter I. is on the design of the magician's stage and table. Chapter II. gives the details of five mechanical illusions, and the following chapter four tricks based on the use of chemicals. Chapter IV. is a reprint of five arti-

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cles on electrical magic which appeared in the columns of this journal, and the final chapter is on equipment and working notes. The book is agreeably written, and all of the apparatus comes within the constructive powers of the amateur.

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Electricity in the Diagnosis and Treatment of Diseases of the Nose, Throat and Ear. By W. Scheppegrell, A.M., M.D., New York: G. P. Putnam's Sons. Large octavo, 161 illustrations. Price, $4.50.

There has been no lack in recent years of works treating of the applications of electricity to medicine and surgery, but none has, until now, been devoted exclusively to a systematic consideration of the uses of this force in diseases of the nose, throat and ear—a branch of the healing art in which, at least as far as diagnosis is concerned, it is probably of greater service than in any other. The book, which is copiously illustrated, contains a concise account of the principles of electro-physics, descriptions of the numerous electrical instruments employed in diagnosis and treatment, and the indications for their use, as well as the modes of examination. The concluding chapters deal with the X-rays, from a physical and clinical point of view.

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Matter, Energy, Force and Work. A Plain Presentation of Fundamental Physical Concepts, and of the Vortex-Atom and other Theories. By Prof. Silas W. Holman. New York: The Macmillan Company. 257 pages. Price, $2.00.

Were the principles so clearly enumerated in this book generally understood, the Patent Office would lose no small part of its revenue, electricity would no longer be considered the transcendant mystery in the realm of Nature, and vast sums of money spent on attempting the impossible would be spared. In other words, the book sets forth the distinctions between force, energy and work, classifies the different forms and clearly presents the principles of conservation and transformation of energy. The final portion of the book is devoted to a statement of the kinetic theory of gases, Le Sage's theory of gravitation, the vortex-atom theory and of other authoritative theories and speculations in the field of physics.

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Magnets and Electric Currents. An Elementary Treatise for the use of Electrical Artisans and Science Teachers. By J. A. Fleming. New York: Spon & Chamberlain. 408 pages, 134 illustrations. Price, $3.00.

For many years one of the best books on the market for those desiring an introductory treatise to electrical science free of mathematics, has been Fleming's "Short Lectures to Electrical Artisans." After the issue of several editions of that book it became necessary to rewrite it, and the result is the present work. The several chapter headings are as follows: Magnets and Magnetism. — Measurements and Units.—Magnetic Force and Magnetic Flux.—Electric Currents and Electromotive Force.—The Measurement of Electric Currents. — Electromagnetic Induction.—Electromagnets.—Alternating Currents.—Electric Measuring Instruments.—Generation of Electric Currents. As a book to serve as an introduction to electrical science, and to prepare the way for the sound understanding of technical treatises on the various branches of electrical engineering, this work can be confidently recommended.

## PERSONALS.

LIEUT. S. DANA GREENE has been promoted to general sales manager of the General Electric Company.

COL. EUGENE GRIFFIN, first vice-president of the General Electric Company, has been promoted to Brigadier-General of Volunteers, in recognition of his excellent service in Puerto Rico while in command there of the First Regiment of Engineer Volunteers.

PROF. SIDNEY H. SHORT, in an article in the January number of the "Cosmopolitan," discusses the subjects of high-speed electric traction, and the employment of electricity on trunk lines. The "Evening Post," in an editorial based on Prof. Short's article, strongly indorses the position therein taken, which is that within a comparatively short period electric traction will reduce the time from New York to Chicago to nine hours, and trunk lines will be operated by electricity.

MR. JOHN McGHIE, for a number of years the advertising and newspaper representative of the General Electric Company, has resigned from that company to join the business staff of the "American Machinist," taking charge of the Western interests of that journal. Mr. McGhie made an enviable record when with the General Electric Company, and possesses both the ability and the social qualities to win success in his new field of work. The "American Machinist" ranks high among the ably conducted technical journals of the world—easily within the first dozen—and it is to be congratulated upon securing the services of one who, in every way, will worthily represent it.

## TRADE PUBLICATIONS.

ELECTRIC WELDING.—The Standard Tool Company, Cleveland, Ohio, has issued a pamphlet devoted to the electric welding line of its business, electrically welded bicycle parts being the subject.

REFLECTORS.—Numerous forms of electric reflectors are shown in a catalogue of the Western Reflector Company, 740 Grand Avenue, Chicago, ranging from types for desk use to reflectors for churches and theaters.

PENCILINGS.—With this title, the Joseph Dixon Crucible Company, Jersey City, Pa., have issued a pamphlet giving much interesting and useful information concerning lead pencils, and their selection for various uses.

LORICATED CONDUIT.—The Safety Conduit Company, Rankin Station, Pa., have issued several circulars giving a list of users of "Loricated" electric iron-armored conduit, and views of some large buildings in which this material has been installed.

EXACT TIME.—The Standard Electric Time Company, Waterbury, Conn., in a recent pamphlet, give much information concerning their system of transmitting by electrical means exact time from a master clock to any number of secondary clocks.

ELECTRIC VEHICLES.—With the title "The Twentieth Century Movement," the Electric Vehicle Company, 1545 Michigan Avenue, Chicago, has issued an attractive pamphlet containing extremely well-executed engravings of several types of electric motor vehicles.

A POCKET REMINDER.—The Sprague Electric Company is sending its friends a handsomely leather-bound ready reminder of daily engagements, which, in addition to the diary pages, includes a number of useful tables and considerable other matter for ready reference.

MULTIPOLAR MACHINES.—Circular No. 44, of the E. G. Bernard Company, Troy, N. Y., is devoted to the description and illustration of its multipolar slow-speed dynamos and motors. The description is a well-written technical account of the machine, not a mere collection of claims.

WARREN ALTERNATOR.—Bulletin No. 8, of the Warren Electric Company, Sandusky, Ohio, is a well-printed and illustrated brochure of sixteen pages, showing in detail the features of the Warren inductor alternator, and pointing out their merit. A number of flattering testimonials from users are included.

ELECTRIC HEATING.—In a fifty-page pamphlet the Simplex Electrical Company, Cambridgeport, Mass., (manufacturers under the patents of the American Electric Heating Corporation), illustrate numerous forms of electric heating apparatus, including radiators, portable stoves, teakettles, stew-pans, broilers, chopping-dishes, ovens, smoothing-irons, heating-pans, etc. An interesting feature of the text consists of tables giving the consumption in watts of all the apparatus listed.

LUNDELL MOTORS.—A beautiful catalogue recently issued by the Sprague Electric Company adds another to the growing list of edition de luxe trade publications. The title is "Electric Power," and the subject is divided into two portions—motors and applications. The numerous engravings are the highest expression of the half-tone art, and the cover is tasteful, both in design and illumination. Among the interesting technical matter is a series of curves, showing the variation of the efficiency of motors of different power, with different loads.

RECORDING WATTMETERS.—The latest achievement of the General Electric press is a beautiful large-page pamphlet on Thomson recording wattmeters, which more than maintains the reputation of this press as one without an equal in its line in this country. All of the various types of Thomson wattmeters are described and illustrated in detail, and diagrams of connections given. A valuable feature consists of a number of pages of general information regarding meters, which includes directions for reading and care, description of record book, price chart, etc.

STURTEVANT LITERATURE.—Bulletins H and I, of the B. F. Sturtevant Company, Boston, Mass., have for subjects electric fans and eight-pole motors and generators, respectively. The former contains fifteen excellent engravings of high-powered electric fans, with descriptions of the same, and the latter is devoted to the latest type of Sturtevant generator. A very handsome pamphlet issued by the same company has on the cover an illuminated title, "Who Uses Mechanical Draft," and on the inside pages lists covering seventeen large pages giving merely the names and addresses of users of Sturtevant fans for the purpose mentioned.

MECHANICAL STOKERS.—The new catalogue of the American Stoker Company, Washington Life building, New York, is executed in the highest style of the printers' and engravers' art; the paper and binding are in keeping. Besides a well-written and illustrated description of the American stoker, numerous views are given of its application to different boilers. An interesting series of engravings is from photographs of a large steam plant, taken at different hours of the day, which show at all hours an absence of smoke from chimneys serving boilers fitted with American stokers, while dense clouds pour out of two chimneys connected to boilers not thus fitted.

MECHANICAL DRAFT.—Among recent publications by the B. F. Sturtevant Company, Boston, Mass., are a second illustrated edition of the lecture on "Mechanical Draft for Steam Boilers," delivered at Cornell University by Mr. Walter B. Snow, of the engineering staff of the Sturtevant Company; an interesting circular entitled "Draft Without a Chimney," telling why the Sturtevant Company took down its tall chimney, how draft is now produced, and how an annual fuel saving of nearly $1000 is secured, and Bulletin G, illustrating and describing a unique generating set, in which both the engine and the generator are entirely

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inclosed, although perfectly accessible through suitable doors. Such a device is of manifest utility wherever the atmosphere is laden with dust. Any of the above will be mailed on application.

CALENDARS.

Of the trade calendars of the year which have come to our desk, those of the Sprague Electric Company and the Okonite Company easily rank first as artistic productions. The former consists of a heavy mat, surrounded by an ebony frame. The lower portion of the mat frames a large calendar, in one corner of the sheets of which are neatly worded seasonable references to Lundell motors, fans, fan heaters, Sprague elevators, etc.—The Okonite calendar consists of an exquisite figure-picture in colors, surrounded by a neat mat; the calendar and word "Okonite" on the mat are unobtrusive, thus not marring the artistic effect.—The calendar of the G. F. Brunt Porcelain Works, East Liverpool, Ohio, consists of six lithographic sheets, each containing as a central piece the picture of a handsome young woman arrayed in an army or navy uniform. The coloring is brilliant and effective, and the effect both artistic and striking. —Another work of art in the proper sense of the phrase is the calendar of the Laclede Battery Company, Kokomo, consisting of a mat framing an etching of an agricultural subject by Peter Moran, entitled "Stacking Time." As in the case of the above-mentioned calendars, the name of the firm and the calendar do not detract from the artistic effect.—A large lithographic engraving in colors of "The Oregon Pursuing the Colon" ornaments the calendar of Geo. I. Roberts & Co., New York, which is printed on heavy cardboard.—The calendar of the Peckham Truck Company is, as in previous years, large in proportions, consisting of twelve monthly sheets 17 x 26 ins. in size. As usual, it is excellently executed in printing, engraving and paper.—The Wm. Powell Company, Cincinnati, Ohio, show in colors on their calendar a large illustration of the Powell regrinding "Star" valve, which is the subject of admiring glances from a female figure regarding it from a seat on the earth, represented by a globe. The Powell Company informs us that a copy of this calendar will be sent to any engineer upon application.—The Monarch Governor & Machine Company, Indianapolis, Ind., have been successful in producing an artistic effect in the decoration of its calendar, with a view in colors of the Monarch governor.—The La Favorite Rubber Manufacturing Company, Paterson, N. J., uses war subjects as a decoration for its calendar, the monthly sheets containing portraits of Dewey, Miles, Sampson, Shafter, and other naval and military leaders in the late war. A copy will be sent to any of our subscribers on application.—The calendar of the Phillips Insulated Wire Company, Pawtucket, R. I., is one of convenient size, and with the dates printed in white on a blue ground.—A small calendar for desk use is issued by the Stewart Heater Company, Buffalo, N. Y., containing views of the Stewart filter and heater.—Another calendar of convenient size is that of Machado & Roller, 203 Broadway, New York, to which an artistic appearance is lent by the handsome engraving used as a trade-mark by the Allgemeine Electricitats Gesellschaft, of which great German firm Machado & Roller are the American representatives.—The Ashton Valve Company, 271 Franklin Street, Boston, ornament their calendar with two portrait figures of children in handsome scrolls, underneath which is the title "Chips of the Old Block." —The calendar of the Joseph Dixon Crucible Company, Jersey City, N. J., has for its pictorial subject a lithograph in colors of an attractive young woman, in college gown, teasing an owl perched on a globe, the head of the bird of wisdom bearing a dunce cap.

## BUSINESS NEWS.

PECKHAM TRUCKS.—Among recent orders for Peckham trucks is one for 160 pairs for the Third Avenue Railroad of New York City.

THE EUREKA TEMPERED COPPER COMPANY has removed its office from 107 Liberty Street to 141 Broadway, corner Liberty Street, New York.

GLASSWARE.—At the recent Manufacturers' Annual Glass Exhibit at Pittsburgh, Pa., the Pittsburgh Glass Company was represented by D. W. Eyman, and showed a large exhibit of gas and electric shades of every description.

THE E. G. BERNARD COMPANY, 450 Fulton Street, Troy, at its annual meeting, held Jan. 10, unanimously re-elected the following officers: President, E. G. Bernard; vice-president, F. L. Stevens; secretary, H. T. Crissey.

THE RAMSDELL ELECTRIC CONSTRUCTION COMPANY, Salem, Mass., desires to receive catalogues from manufacturers of annunciators, automatic fire alarms, telephones for private lines, and electric house goods generally.

THE AMERICAN ENGINE COMPANY, Bound Brook, N. J., owing to the growth of its business, has opened a New York office in the White building, 95 Liberty Street, which will be in charge of Edwin S. Boyer, formerly of Philadelphia.

AMERICAN CATALOGUES WANTED.—We are requested to say that Gregg & Barrell, Standard building, Johannesburg, S. A. R., desire to receive catalogues from American manufacturers of electrical goods of all kinds, together with price lists.

THE C. & C. ELECTRIC COMPANY has removed its Philadelphia office from 633 Arch to much more commodious and attractive quarters at 45 North Seventh Street, where the manager, Mr. William Myers, will be glad to welcome the friends of his company.

MR. JOHN E. FULLER, 93 Maiden Lane, New York, has recently succeeded to the business of the North American Electric Company, of 181 William Street, New York. Mr. Fuller is sole owner and proprietor of the business, having no connection with any one else.

THE CENTRAL TELEPHONE AND ELECTRIC COMPANY, 909 Market Street, St. Louis, Mo., has in its new office, sample room and factory 8500 ft. of space entirely devoted to telephone goods. Everything, from telephones to fuse blocks, is carried in stock, and thus all orders can be promptly handled.

CARD GENERATORS AND MOTORS.—Among recent sales of Card apparatus by J. Holt Gates & Co., Western agents of the Card Electric Company, Mansfield, Ohio, were one 225-kw. 500-volt generator, two 150-kw. 500-volt generators, and twelve motors aggregating 880 h.p., all to be installed in the Armour glue works, Chicago.

JAMES McCREA & CO., 11 South Canal Street, Chicago, manufacturers of the Climax steam joint clamp, report a rushing business with the opening of the new year. An agency has been established with Messrs. McArdle & Co., 514 Camp Street, New Orleans, who carry a complete stock, and will look after the adjacent territory.

CRESCENT TELEPHONES.—The Pennsylvania Electric Company, Marietta, Pa., was awarded a bronze medal for its telephone apparatus exhibited at the Omaha Exposition. The award was the result of a special effort, but given on a line of samples exhibited by the company's local agent.

C. B. ARSINO finds, after eight months of successful business, that he has outgrown his present quarters at 125 Massachusetts Avenue, Boston, and he has taken a lease of 18 Cambria Street, Boston. In addition to his former work in electrical and mechanical repairing, Mr. Arsino will add an electro-plating branch to his business.

FERRACUTE MACHINES.—The demand on their manufacturing facilities has necessitated a considerable enlargement of the works of the Ferracute Machine Company, of Bridgeton, N. J. No small part of the business of this firm is the manufacture of presses and dies for electrical work, many shipments of which are on foreign orders.

FEED-WATER HEATERS.—That the Cochrane feed-water heaters, made by the Harrison Safety Boiler Works, Philadelphia, is appreciated by owners of electric railway and light plants is shown by a list of such users, recently issued. The most substantial plants in the country are represented in this, many of them having from 1000 to 3000-h.p. capacity installed.

THE GEO. C. TOWLE MANUFACTURING COMPANY, of Lancaster, Pa., have moved into new and much larger quarters, their new factory building being 150 x 75 ft. and two stories in height. Three months' orders are now in hand, among which is one for a complete equipment of fan motors for the new United States Mint building in Philadelphia.

THE CUTLER-HAMMER MANUFACTURING COMPANY, 70 West Jackson Boulevard, Chicago, Ill., has greatly increased its manufacturing facilities, and now claims to have the largest and the finest equipped factory devoted exclusively to the manufacturing of rheostats in the world. This, they say, with the large volume of business done, has enabled the price of rheostats to the trade to be materially reduced.

HARRISON PRIMARY CELL.—The Thermo-Electric Company, "Times" Building, is offering a primary battery having an e.m.f. of 2.45 volts, lead peroxide being the positive element and self-amalgamating zinc the negative. The capacity of a cell is 40 amp.-hours, and the makers claim that it is the most powerful and economical cell made for all open-circuit and semi-closed circuit work—such as bells, telephones, annunciators, burglar alarms, physicians' and dentists' lamps, etc.

FAN MOTORS FOR EXPORT.—The Emerson Electric Manufacturing Company, of St. Louis, received a few days ago an order from China for a number of desk and ceiling fans, amounting to about $1300, and the next day an order for a quantity of its alternating current ceiling fans, which were to be shipped to South America, amounting to about $675. In addition to these orders, the demand for Emerson fans has been unusually active from the larger cities in the United States.

ROEBLING CONSTRUCTION COMPANY.—Under this name a company has been incorporated under the laws of New Jersey, to engage in the manufacture of iron for fire-proof buildings. Of the 500 shares of the company, 260 are held by Frederick Roebling, 170 by Frank H. Croker (son of Richard Croker of New York), 50 by J. W. Hinkley, late chairman of the New York State Democratic Committee, and 10 each by Chas. G. Roebling and Frank O. Briggs.

INTERIOR TELEPHONES.—The Allen-Hussey Company, Chicago, Ill., the well-known manufacturers of interior telephones, have been meeting with such a gratifying demand for their product in the East that they have recently opened a New York office at 101 Beekman Street, where a complete line of their telephones will be kept in stock, and from which all Eastern orders can be filled promptly. Mr. W. R. Allen, of this company, will have charge of the Eastern office.

HANCOCK INSPIRATORS IN CUBA.—Mr. M. J. Martinez has received the appointment as resident agent at Havana, Cuba, for the Hancock Inspirator Company, manufacturers of injectors, ejectors, general jet apparatus and specialties for steam, water, air and gas. The business will be conducted under the style of M. J. Martinez, consulting and contracting engineer. Mr. Martinez will be prepared to submit estimates on all the different lines of apparatus manufactured by this company.

"COMMERCIAL" DYNAMOS IN JAPAN.—The Commercial Electric Company, Indianapolis, Ind., has recently installed a complete lighting and power plant for the Omi Mashi-Boseki Kwaisha, Kioto, Japan, which is a large flax spinning mill. All the machinery and supplies furnished were of American manufacture and installed through the Commercial Company's agent, Paul G. Fiedler, Yokohama. This is the fourth plant installed for the Commercial Company in Japan by Mr. Fiedler within the last few months.

FILER & STOWELL ENGINES.—Among recent sales of engines by Filer & Stowell, Milwaukee, Wis., are a 22-in. x 48-in. Corliss engine to the Menominee (Mich.) Electric Light, Railway & Power Company; a tandem compound engine, 10½ ins. x 20 ins. x 42 ins. stroke, to the Washburn & Moen Company, Worcester, Mass.; a

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26-in. x 60-in. Corliss engine for the Whitney Iron Works, New Orleans; a 500-h.p. engine for the United States Glue Company, Milwaukee, and two 1000-h.p. engines, to Armour & Company, Chicago, for direct connection to generators.

MANHATTAN INCLOSED ARC LAMPS.—Mr. Stuart W. Wise, who was formerly treasurer of the Manhattan General Construction Company, has opened an office in the John Hancock building, 178 Devonshire Street, Boston, Mass., the former New England address of the Manhattan Company. Mr. Wise will push the sale of the Manhattan inclosed arc lamps from the above address. The company manufactures lamps for direct current circuits to operate singly on 110 to 220 volts, two or more in series on 220 to 550 volts, and to operate singly or in series on alternating current circuits.

BABCOCK & WILCOX BOILERS.—Sixty boilers of 520 h.p.—such is an order recently received by the Babcock & Wilcox Company, from Westinghouse, Church, Kerr & Co., which is said to be the largest single order for boilers ever given. The boilers are for the power house of the Third Avenue Railway Company, now being erected at 218th Street and Harlem River. The boilers will carry steam of 200 lbs. pressure, and, owing to the economy of the type of engine with which they will be used, now being designed by Westinghouse, Church, Kerr & Co., will be of sufficient capacity to supply steam to sixteen engines of 4000 h.p. each.

MR. H. W. WISWELL, electrical engineer, formerly with the General Electric Company, and who has been for the past year associated with the New York & Ohio Company as manager of its transformer department, makes the announcement that he has resigned his position with that company, his contract having expired, and has associated himself in a similar capacity with the Warren Electric & Specialty Company, Warren, Ohio. This company will place upon the market its new "peerless" transformers, which will be a distinct improvement upon anything now on the market, and expects to be able to make deliveries about April 1, 1899.

MURPHY AUTOMATIC SMOKELESS FURNACES are to be placed in connection with six water tube boilers of 250-h.p. rated capacity each, for the Union Iron & Steel Company, Youngstown, Ohio. Other recent sales are: Standard Plate Glass Company, Butler, Pa., three; Morrell & Company, Ottumwa, Iowa, an additional two; Northern Milling Company, Chicago, an additional two; Water Works, City of Detroit, additional four; Detroit Copper & Brass Rolling Mill, seven; Ford's New Plate Glass Works, Toledo, Ohio, eight; Michigan Alkali Company, Wyandotte, Mich., additional six, making forty-five in all sold this company within a year.

CAHALL BOILERS IN CUBA.—Mr. M. J. Martinez, member of the American Society of Mechanical Engineers, has received the appointment of resident agent at Havana, Cuba, for the Aultman & Taylor Machinery Company, Mansfield, Ohio, manufacturers of the "Cahall" vertical and the "Cahall" horizontal water tube boilers. Business will be conducted under the style of Mr. M. J. Martinez, consulting and contracting engineer. Mr. Martinez will be prepared to submit estimates on all the goods manufactured by the above named company, the vertical type of boiler being claimed by them to be especially adapted to the conditions and needs of the sugar industry in Cuba and Puerto Rico.

JENNEY MACHINES.—The Jenney Electric Manufacturing Company, of Indianapolis, Ind., now has its new plant well equipped for the manufacture of its well-known dynamos and motors, and while the plant which was destroyed by fire has only been rebuilt since about the 1st of September, the company is greatly crowded with work. Mr. Chas. D. Jenney, who is known the world over as one of the pioneer inventors and designers of electrical machinery, is at the head of the company, which insures the very latest improvements in electrical apparatus. This is undoubtedly the cause of the company meeting with such large demand for their apparatus, and inquiries from all over the country. They have had inquiries from Russia, England and Japan within the last ten days.

MURPHY STOKERS.—The Murphy Iron Works, of Detroit, Mich., has closed a contract with Armour & Co., of Chicago, for equipping the twelve 375-h.p. boilers in the latter company's new central station at the Stock Yards, Chicago. Many other installations have been recently made by the Murphy Company, and users of power are realizing more than ever the economy obtained by using the Murphy furnaces. Mr. O. D. Cotton, general sales manager of the Murphy Company, reports a greater number of installations on hand than ever before in its history, and he predicts an unusually heavy year's business in 1899 for his company. Mr. W. G. Amos, Chicago agent of this company, states that the prospects in and contingent to Chicago are unusually bright, and he is assured of a large number of new installations and perhaps a larger number of additions to plants in which the Murphy furnaces are already installed.

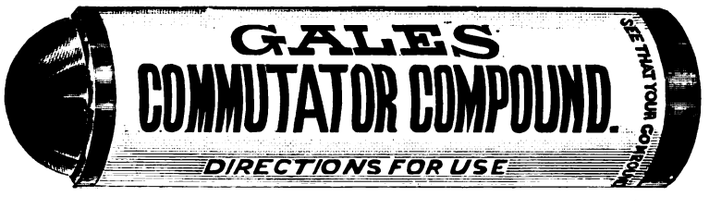
ORIENT INCANDESCENT LAMP.—A combined mechanical and chemical process is now employed by the Orient Electrical Company, of Youngstown, Ohio, for securing the vacuum in the bulbs of its incandescent lamps. The mercury pumps were thrown out a year ago, and mechanical pumps installed which, operating in connection with a chemical process, facilitate the gaining of the desired vacuum. By the new process an attendant is able to exhaust and seal 500 lamps in ten hours, or about 50 an hour. In the process a high tension-current is employed, which quickly drives the gases from the filament and produces a very efficient lamp, which maintains a practically uniform candle power throughout its entire life. Some of the peculiar features of the Orient lamp are that the filament is anchored from the mount, and the loop is made oblong, instead of circular. The Orient Company has opened a New York office in the Havemeyer Building, 26 Cortlandt Street, of which Mr. Francis Granger is manager.

CORRESPONDENCE INSTRUCTION.—The American School of Correspondence, Boston, Mass., offers special advantages to those desiring to pass Government examinations. Its object is to give the busy engineer or mechanic a thorough technical training in steam, electrical and mechanical engineering. The instruction is carefully graded, thoroughly practical and scientific, and is supervised by experts who are in close touch with the developments of the age. All instructors in the school are graduates of the leading technical schools, while the advisory board is composed of such well-known men as Dr. Robert Grimshaw, Charles Thom, Francis H. Boyer and others. The school is chartered by the Commonwealth of Massachusetts, and is warmly indorsed by the leading educators and engineers throughout the country. It is strictly an educational institution, founded for the "advancement of the American mechanic," and the tuition fee is therefore placed within the reach of all wage earners. Engineers would do well to write for a handbook.

A CLEARING HOUSE FOR BRAINS.—Under this unique title, the Technical Agency, 1360 Monadnock block, Chicago, announces to manufacturers and employers of engineering help that they can save them time, trouble and money in securing skilled and educated employees, such as electrical and mechanical engineers, draughtsmen, experienced superintendents and competent engineers and foremen. The Technical Agency charges the manufacturer nothing for their services, but solicits the privilege of putting before them the data and records of their candidates. The agency exercises great care in selecting each candidate for a position, and, as it will not knowingly recommend an applicant unless it feels assured that he is fully competent, the employer is thus put into communication with the exact class of employee he desires. We are informed that a large number of skilled men have been placed in good positions during the past few weeks, and that such manufacturers as have availed themselves of the Technical Agency's facilities express themselves well satisfied with this company's methods.

THE WARREN ELECTRIC MANUFACTURING COMPANY, of Sandusky, Ohio, has appointed J. Holt Gates & Co., 1426 and 1427 Marquette building, Chicago, general agents for its apparatus in the Western territory surrounding Chicago. The Warren Company has recently placed, through J. Holt Gates & Co., a 15,000-light alternating-current plant for the great new power and light plant of Armour & Co., at their extensive works at the Union Stock Yards, Chicago. This plant will consist of one machine of 7000 16-candle power light capacity, at 1100 volts and 7300 alternations; also two 3600 lighters, 1100 volts and 7200 alternations. These alternators, of the inductor type, will be operated by rope drive from Corliss engines of 2000 h.p. and 1100 h.p. each, to which engines will also be attached Walker direct-connected power generators. It is stated that the Warren alternators were selected on account of their close regulation, high efficiency, low temperature and ability to stand "grief." The Warren Electric Manufacturing Company is now prepared in its new factory to build 10,000 light machines, both single and two-phase. It has over sixty machines on order at the present time. Its new plant at Sandusky, O., is modern and up to date.

**SPARKING** reduces the working capacity of a motor or dynamo, wears out the commutator wastes power and may cause a fire. All of these may be avoided if you use




**The Only Article that will Prevent Sparking.**
**Will keep the commutator in good condition and Prevent Cutting.**
**Absolutely will not gum the brushes.**
**It will put that high gloss on the Commutator you have so long sought for.**

**50c. per Stick. $5.00 per Dozen.**

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**K. McLENNAN & CO.**
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## CONVENTION NOTES.

MR. GEORGE CUTTER allowed no one to forget the Cutter specialties.

MR. J. H. FORD, consulting engineer, of Madison, attended the convention.

THE YARYAN COMPANY'S system of steam heating was explained by Mr. A. J. Stahl, of La Porte, Ind.

MR. JOSEPH B. CHAMBERS, superintendent of construction for Julius Andrae & Co., of Milwaukee, was present.

"POMERY-SEC," otherwise, J. G. Pomeroy, of the McGill-Pomeroy Company, Chicago, added lustre to the occasion.

PROF. DUGALD C. JACKSON greeted his many friends, and presented an able and interesting paper to the delegates.

"UNCLE" GEORGE SEARING bobbed up serenely the last day, and "switched" the conversation onto Hart & Hageman goods.

STANDARD TELEPHONE & ELECTRIC COMPANY, Madison, Wis., had two representatives present at the convention.

ILLINOIS ELECTRIC COMPANY, 239 Madison Street, Chicago, was represented by Mr. D. Dewey Newman and Mr. H. E. Adams.

MR. A. J. STAGG kept the interests of the Northern Electric & Manufacturing Company, of Madison, prominently before the convention.

THE WRIGHT DISCOUNT METER COMPANY was represented by Mr. Chas. D. Heile, of Chicago, and also comprised a part of Mr. Insull's exhibit.

CHICAGO GENERAL FIXTURE COMPANY, through their genial and courteous representative, F. A. Overbaugh, made many new friends and customers.

MR. CHARLES F. COOPER, superintendent of the Chicago Rockford Hosiery Company, of Kenosha, had an eye out for the good things in the electrical field.

WALLACE ELECTRIC COMPANY, 1506 Marquette building, Chicago, exhibited the Chicago inclosed arc lamp, and was represented by Edward L. Barr, the company's secretary.

CLOOS BROTHERS, manufacturing agents, 29-30 Calker building, Milwaukee, were represented in the person of Mr. Jacob Cloos, who greeted his many friends and renewed old acquaintances.

A. LOUIS KUEHMSTED AND FRANCIS B. RAYMOND were on hand, and, by no means, "second hand," in keeping the interest of the Charles E. Gregory Company prominently before the convention.

MR. A. C. JACKMAN, MR. CHARLES C. RUSSELL AND MR. VALENTINE, of the Rock County Telephone Company, Janesville, Wis., visited the convention and were very much interested in telephone exhibits.

MR. M. D. AUSTIN, 321 Dearborn Street, Chicago, was present, as was also Mr. W. A. Brown, of the M. D. Austin Company. These gentlemen showed a large line of specialties, safety wires and cables, Loricated conduit, and also the New York switch.

THE ELECTRIC APPLIANCE COMPANY, Chicago, through Mr. W. W. Low, dispensed hospitality hard to equal. Every one who knows "Billy" Low is his friend, and as nearly every one knows him his friends are legion. Mr. Low was assisted by Mr. B. B. Downs.

MR. GEORGE S. SEARING looked out for the interests of the Hart & Hegeman Manufacturing Company, of Hartford, and took every opportunity to convince delegates of the merits of the H. & H. switch. Mr. Searing was not overworked, as conviction was not difficult to secure.

JOHN A. ROEBLING'S SONS' COMPANY was represented by Mr. A. G. Conover, Jr., 171-173 Lake Street, Chicago. This company presented every attendant with a beautiful pocket-case and memorandum, a souvenir that was highly appreciated, and will be long prized by the recipients.

THE LIBRARY BUREAU, 215 Madison Street, Chicago, was present in the person of Roger A. Simmons. The system exhibited by Mr. Simmons was one of the most interesting exhibits made, and central-station men not acquainted with it would do well to investigate this system.

COLUMBIA INCANDESCENT LAMP COMPANY, St. Louis, added brilliance to the convention by the genial beams that radiated from the kindly countenance of George P. Rex, acting secretary of this company. A more popular salesman than Mr. Rex is not to be found in a long day's journey.

ELECTRICAL SUPPLY COMPANY, Madison, Wis.: Mr. L. W. Burch was, as usual, on exhibition. Mr. Burch did not make any new acquaintances at the convention, as he already knows everybody in the Northwest, and his many friends join us in wishing him long life, health and prosperity.

CLOOS ELECTRICAL ENGINEERING COMPANY had its interests well attended to by Mr. H. R. King, the treasurer of the company. Mr. E. A. Wurster, the secretary, also lent his presence to the brilliance of the assembly. Mr. James Asten, assistant engineer of the company, aided in exploiting the Cloos junction box, transformer, cut-out, etc.

MR. MARTIN J. INSULL, Monadnock block, Chicago, represented the Pittsburgh Transformer Company, Pittsburgh, Pa., with an exhibit of its new transformer, including accessories. Mr. Insull was much pleased with the favorable comment which he heard concerning the new transformer, whose special features appeared to appeal with force to the central-station men at the convention.

CENTRAL ELECTRIC COMPANY, Chicago, had on exhibition the Zeco arc lamp, which is claimed to be the latest type for direct and alternating current, and is easy to adjust and easy to install. A very strong point of this lamp is the clutch, which is very simple and positive. In most types of inclosed lamps the current is conveyed to the carbon through the clutch. This is not the case with the Zeco.

THE WESTERN ELECTRIC COMPANY, Chicago, had a large line of its handsome circular matter prominently displayed. The Stanley Electric Company's alternating current apparatus and Western Electric apparatus and supplies were well and ably presented to the attention of the visiting delegates by Mr. W. S. Hine and A. McNab Little. A beautiful souvenir pocket card-case was one of the features.

MR. MARTIN J. INSULL, manufacturers' agent, 1012 Monadnock block, Chicago, was present, and in his genial manner acquainted the





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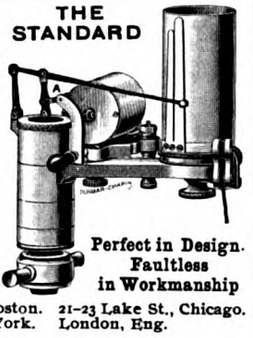
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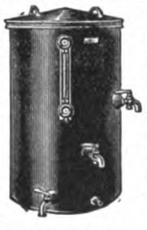


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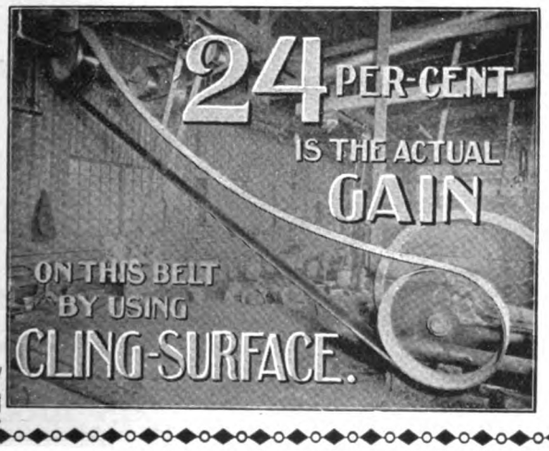
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delegates present with the many good specialties which he handles, among which were C. & C. dynamos and motors, Paragon fans, Pittsburgh transformers, Chapman voltage regulator, Bergmann switches, Cling surface, etc., etc.

THE DEARBORN DRUG & CHEMICAL COMPANY, Chicago, through its assistant manager, Mr. W. J. Jameson, and Mr. J. M. Frye, its Milwaukee representative, presented some very interesting exhibits of samples of boiler tubes thickly incrusted with scale, and other cases showing their condition after using Dearborn compounds. Another feature was the exhibition of Dearborn lubricants. The gentlemen also made the delegates happy by their beautiful souvenirs, with which every delegate was supplied.

SPRAGUE ELECTRIC COMPANY, Parlor 7, was well looked after by Mr. E. D. Kittle and Mr. Chas. D. Burton, assisted by Julius Andrae & Co., the Wisconsin agents of the Sprague Electric Company. Of the latter company, Mr. Herman Andrae and Mr. J. S. Healy were present. These gentlemen talked Lundell fan motors, Sprague elevators and interior conduit with an ease and gracefulness of expression that pronounced them thoroughly acquainted with their subject, and it is almost unnecessary to state that they acquitted not only their company, but themselves, handsomely.

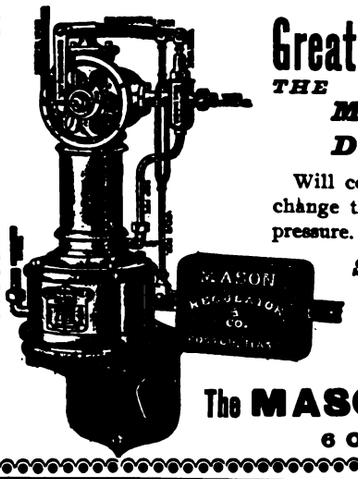
WAGNER ELECTRIC MANUFACTURING COMPANY, St. Louis, had on exhibition a single-phase, automatic, self-starting motor, connected to a dynamo, which in turn ran a direct current 24-in. blower; all connections were made through a switchboard of the Wagner Company's own make. The switchboard was handsomely mounted with a Wagner illuminated dial and instruments, watt-meter, ammeter and the popular Wagner break switches. It also exhibited its line of transformers, cut-outs, reinforced by a variety of printed matter. Mr. E. H. Abadie, general manager of sales, and Mr. A. D. Foster did the honors for this company.

THE VICTOR TELEPHONE COMPANY, Chicago, was represented in the persons of Mr. Wm. T. Blaine, president and manager; Mr. O. D. Rousseau and Mr. C. C. Caden, of their electrical corps. The latter gentleman has had a long connection with the Bell Company, and from his long experience with telephone interests his opinion is worthy of great weight and consideration when he pronounces the Victor metallic switchboard to be the most advanced from the standpoint of scientific correctness and mechanical perfection. This switchboard was on exhibition, and this company's telephone exhibit was the only complete one at the convention. These gentlemen and Mr. Blaine especially made many warm friends, and last, but not least, a number of sales of Victor apparatus during the three days they were present.

GENERAL ELECTRIC COMPANY had present Mr. F. N. Boyer, of Chicago; Mr. J. Scribner, Mr. R. A. Swain, Mr. Wilcox and the genial and irresistible Mr. Tom Ferris, of Milwaukee. For the first time in the history of the Northwestern Convention this company made no exhibit of apparatus, but it had at its headquarters in Parlor 5 a large amount of printed matter, and the courteous gentlemen present introduced to their many friends two new features of this company's production—a line of single induction motors and two-rate meters, both of which attracted much attention from the delegates, especially the operating central-station man. The meter mentioned supplies a long-felt want by placing the central-station man in the possession of an instrument whereby he can measure the amount of current consumed at the peak or the valley of the central-station load.

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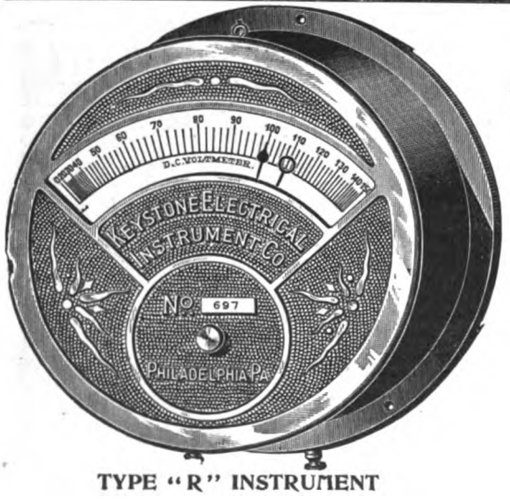
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# American Electrician.

Vol. XI. New York, March, 1899. No. 3.

## ELECTRICITY IN PRINTING, BINDING AND ENGRAVING.

### SPECIAL APPLICATIONS OF ELECTRIC POWER.

The application of electricity to the various processes employed in printing, binding, engraving and kindred arts has become so popular that electrical engineers are now much interested to become acquainted with data on this very important subject. The power and speed of motors which are well adapted to run various kinds of apparatus and the details of the various heating devices used in these arts, comprise valuable data. Further than this the details of application are much to be desired by those who contemplate or are even likely to have anything to do with such installations.

Without further excuses, it is therefore proposed to describe in this article the electrical equipment of the printing department of the Bradstreet Press and of the New York Life Insurance Company. Taken together, they probably represent the very highest development of the application of electricity to printing, binding and engraving.

The subject of electrically driven presses has been taken up before in these columns, and for this reason has received, in the case of these two plants, somewhat less attention than the apparatus in the other departments.

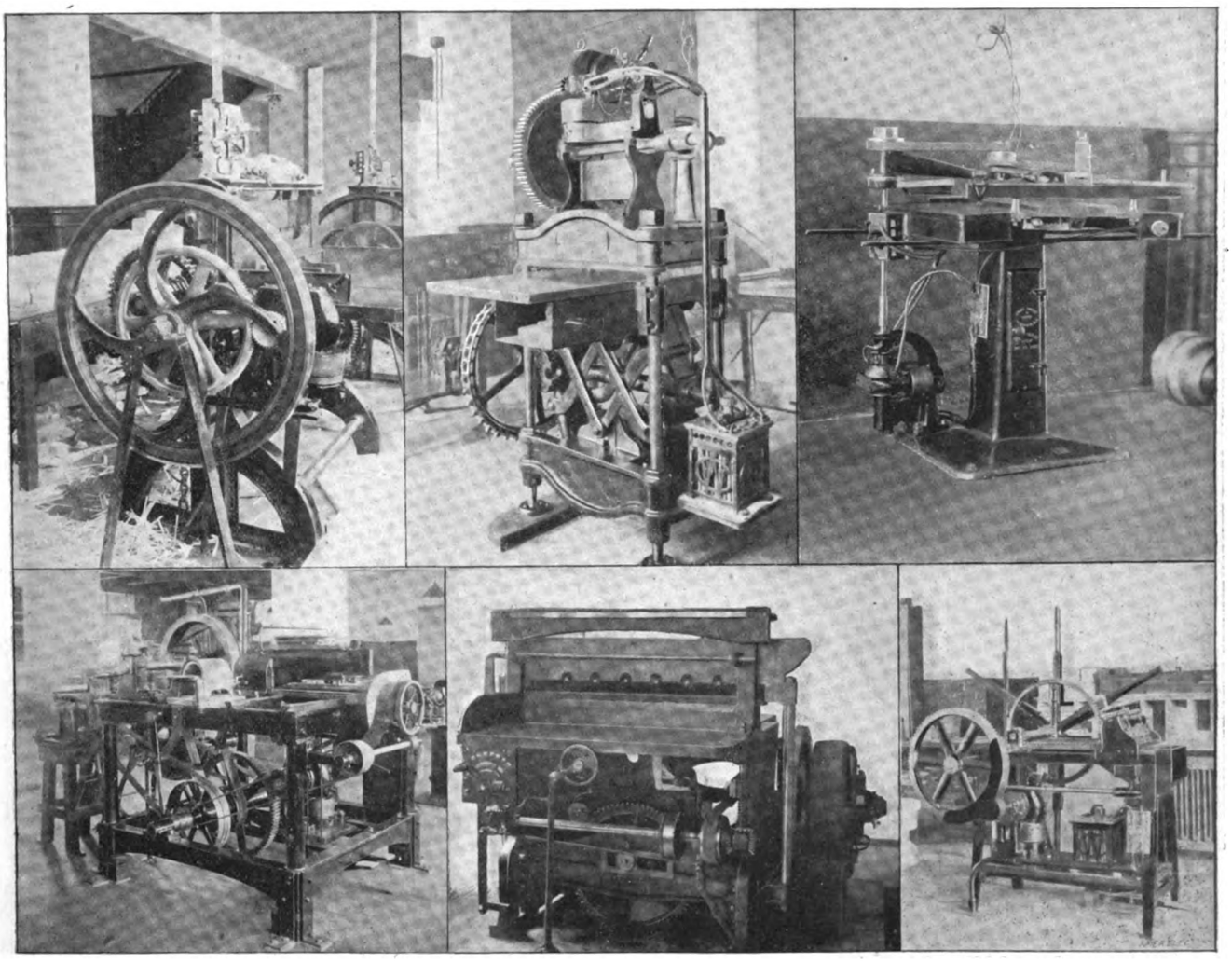


Fig. 1.—Light Paper Cutter.
Fig. 4.—Rough Shaver

Fig. 2.—Wax Former.
Fig. 5.—Heavy Paper Cutter.

Fig. 3.—Routing Machine.
Fig. 6.—Smooth Shaver.

ELECTRICALLY DRIVEN ENGRAVING AND PAPER CUTTING MACHINERY.

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Perhaps the first notable application of motors to printing presses was in the case of the larger sizes of cylinder presses, and all of the cylinder presses in both of these installations are so driven. Fig. 14 shows a motor directly connected to a press of this type in a manner with which most engineers are familiar. The motor shown is the Crocker-Wheeler, which type is used throughout the installations with but one exception, which is noted beyond.

This particular form of motor lends itself exceedingly well to the purpose for which it is intended. The inwardly pointing radial poles make the machine circumferentially iron clad, and this iron inclosure is somewhat enhanced by the overlapping sides of the yoke, which is of a U shaped section and partly includes the field winding. The armature of this machine is very short and of large diameter, giving a high conductor velocity and a correspondingly large output, weight and speed considered. This machine operates noiselessly and is amply sufficient to drive the press.

In the Bradstreet Press room there are eight presses driven in this manner. The following table of their dimensions is of interest in this connection:

| Press | Motor h.p | Motor speed | Form | Imp. per hour |
|---|---|---|---|---|
| Hoe ..... | 2. | 165 | 23x29½ | 1800 |
| Hoe ..... | 2.5 | 113 | 33x46 | 1700 |
| Cottrell ..... | 3. | 165 | 33x46 | 1700 |

The allowance of power has been found to be very liberal. These motors are controlled by a little cylindrical controller, the details of which are shown in Fig. 17. An adjustable resistance is also provided which is in series with the motor, and by means of which the speed of the controller can be varied between notches. This is a valuable adjunct, for it enables the speed of the press to be very finely graduated.

As is well known, fine half-tone work and color printing require a much slower speed than ordinary type printing, and it is important to be able to run the presses at the exact speed necessary to properly execute their work. A slight difference in the speed of the motor might mean several hours loss of time in running off the form.

In the Bradstreet press room are also three small presses of the Colt's armory type, run by little motors geared directly on the circumference of the large fly wheel. The application of the motor is extremely simple and is shown in Fig. 18. These motors are controlled by an automatic regulating box and switch. These presses use a bipolar motor rated at ½-h.p., the speed being 1200 r.p.m. They are geared to the presses by a rawhide pinion. These presses are for small work, and can make 2000 impressions of a 10-in. x 15-in. form per hour. The New York Life Insurance Company also uses presses of this same type and capacity. It is interesting to note that all of the presses of the Bradstreet

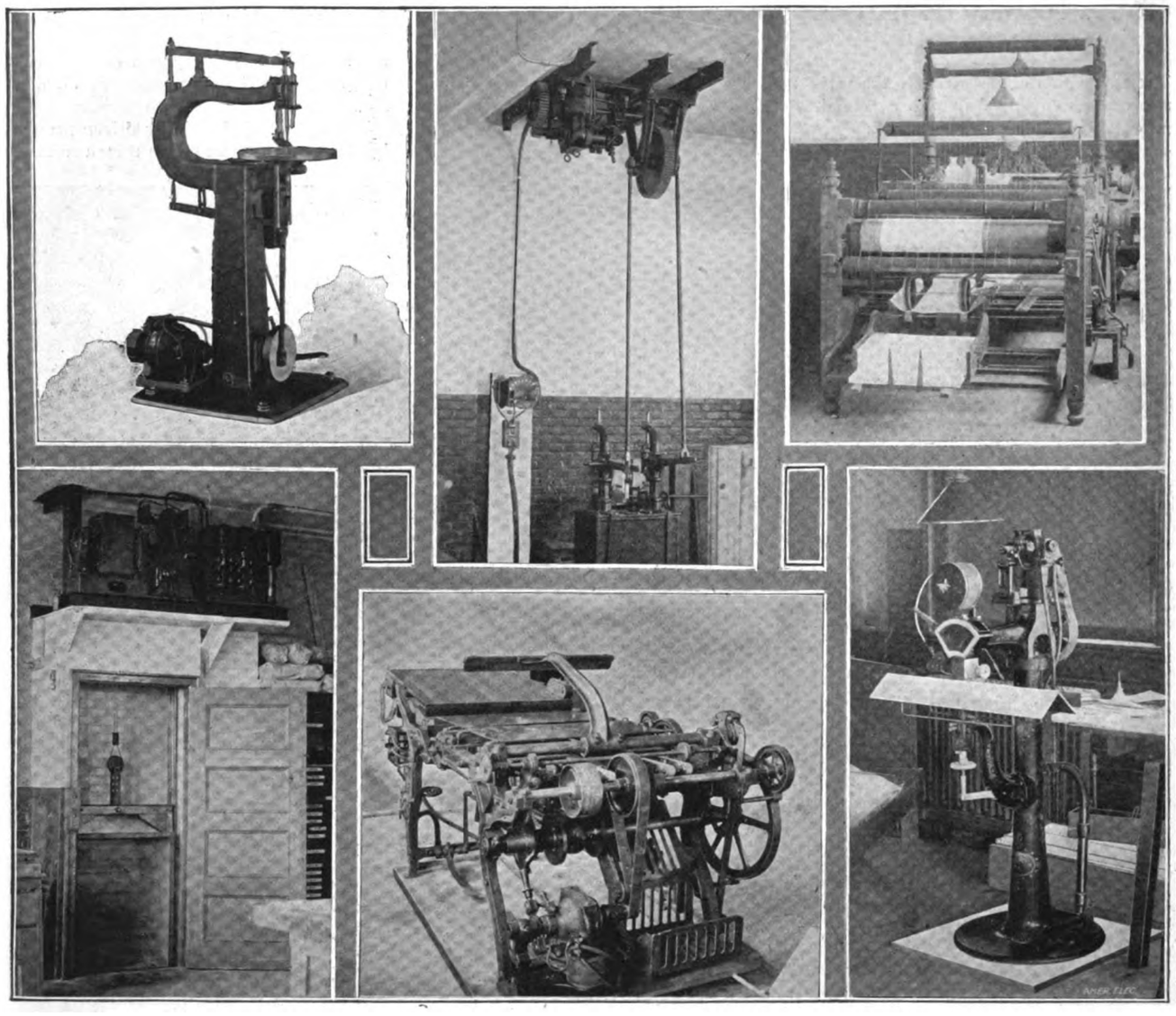


Fig. 7.—Engraver's Jig Saw.
Fig. 8.—Hydraulic Pump.
Fig. 9.—Ruling Machine.
Fig. 10.—Form Elevator.
Fig. 11.—Folding Machine.
Fig. 12.—Stapling Machine.

ELECTRICALLY DRIVEN ENGRAVING, BINDING AND OTHER MACHINERY.

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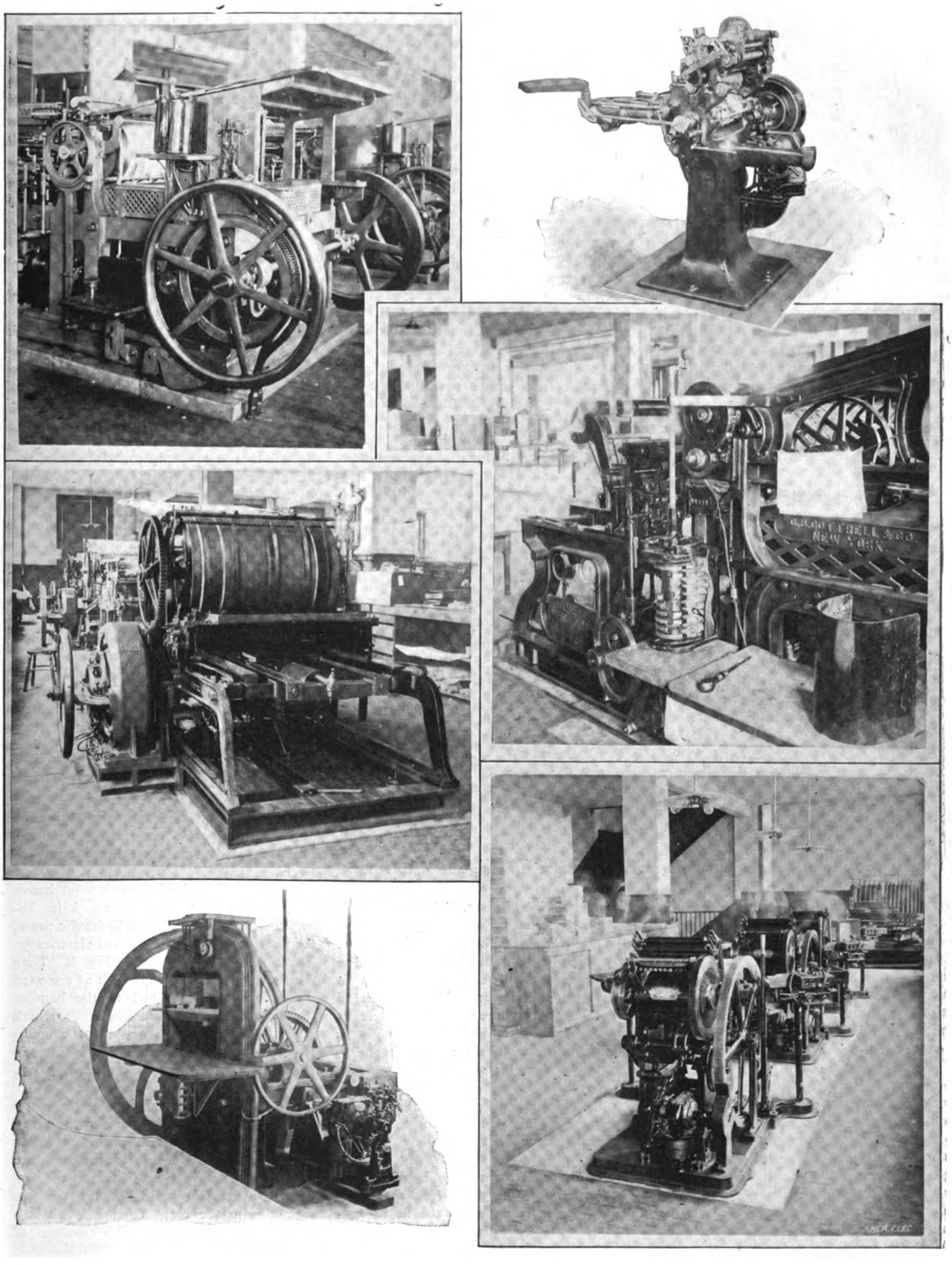


Fig. 13.—Geared Stop Cylinder Press.
Fig. 14.—Direct-Connected Cylinder Press.
Fig. 15.—Embossing Press.
Fig. 16.—Envelope Press.
Fig. 17.—Motor Controller.
Fig. 18.—Geared Colts' Armory Presses.

ELECTRICALLY DRIVEN PRINTING MACHINERY.

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Company, and it may be added, all of their motor driven apparatus, are each provided with its individual circuit-breaker and fuse, even the smallest motors. These circuit-breakers are variously mounted, as shown in the illustrations. Some are conveniently mounted on adjacent pillars, and some are to be found on the back of the little board on which the starting box is mounted.

An interesting modification of motor practice in driving large presses is shown in the case of the stop cylinder press used by the New York Life Insurance Company. This is illustrated in Fig. 13. The feature of this arrangement is that it consists of a motor tucked away beneath the press, and connected thereto by a single reduction of gears. Inasmuch as the direct-connected motors are specially made for the purpose and are necessarily larger and more expensive, and, moreover, actually occupy more room than the geared motors, it becomes a question as to which practice is to be preferred, and whether or not the elimination of the noise of the gears from the multitude of other noises that a cylinder press produces, justifies the greater expense.

Motors direct-connected to printing presses were probably first used in the New York Life's printing department, having been introduced there as early as February, 1894. After five years' experience, the geared motor has been definitely fixed upon as the best and cheapest, under the conditions existing, and by use of a rawhide pinion the noise is reduced to a minimum.

An interesting example of the application of electric motors to printing presses is shown in Fig. 16. This little machine is intended for printing envelopes, which it can turn out at the rate of 10,000 per hour. It is a double cylinder press, the platen consisting of one cylinder, while the electrotype is bent smoothly about the other. The two run together and the envelopes are fed automatically between them. The speed is limited only by the number of impressions which it is possible to take from the plate in a given time. No difficulty is found in feeding the envelopes or receiving them. A large circular receiver is pivoted on an arm which projects from the back of the press, as shown in the figure. This receiver was removed in order to show the motor, which is of ½-h.p. capacity and runs at a speed of 1200 r.p.m.

These two establishments use a great deal of paper, which is cut to size on electrically driven paper cutters. A small cutter thus driven is to be found in the binding department of the Bradstreet Press and is typical of others installed there. This cutter (Fig. 1) is driven by a small motor suitably mounted on a bracket, and geared to the flywheel shaft. It is of 1-h.p. capacity and runs at a speed of 900 r.p.m., operating a cutter with a 32-in. blade. The power used is considerably less than the full load capacity of the motor.

An exceptionally large cutter of the Kent make (Fig. 5) is on the first floor of the printing department of the New York Life Insurance Company. This is direct driven by a multipolar motor of 3.5-h.p. capacity and running at 380 r.p.m.. The cutter has a 40-in. knife which the motor operates very rapidly indeed. It is shown in Fig. 5.

In the department of binding, both of these institutions furnish some very interesting applications of electricity. An electric embossing press is an object of interest and appears in Fig. 15. This machine is used for performing the heavy gilt embossing and printing on the covers of the large Bradstreet books, and similar work. The book or cover to be operated upon is placed on the lower table and forced against the upper one, which is electrically heated. The heating device has four grades of temperature as follows: First heat, 250 deg. to 300 deg. F.; second heat, 300 deg. F., approximately; third heat, 400 deg. to 500 deg. F.; fourth heat, 600 deg. F., approximately. The working temperature is about 300 deg. F. The heating head is made up of six coils, which are connected in various combinations by means of two switches.



FIGS. 19, 20 AND 21.—ELECTRIC GLUE HEATER, FINISHERS' HEATER AND GLUE POT.

This device is probably the first of its kind ever made, and its great success indicates that it will probably be widely adopted elsewhere. It was installed, together with the entire Bradstreet equipment, by the firm of Clark & MacMullen, consulting engineers.

The lower table is forced upwards by means of a heavy toggle joint which is operated from a shaft on which is mounted a large fly wheel. This machine is driven by a motor of 1 h.p. capacity, operating at a speed of 900 r.p.m. The power used is considerably less than this, however.

Another feature of the Bradstreet binding department is the electric glue heater, which is shown in Fig. 19. It contains two heating coils for warming the water bath, in which the glue pots are placed. There are two grades of heating, the highest of which will bring the water to boiling point in forty minutes. The lower heat maintains the temperature thus acquired. An insulating sheathing surrounds the exterior of the water bath.

A smaller device of the same character and principle is shown dismantled in Fig. 21. In this device there are two heating coils threading between each other. Either of the coils can be switched in service, thereby giving two degrees in temperature.

It remains to be said that the workmen in the binding department are particularly pleased with the electrical methods and declare them to be very convenient and reliable. The heating apparatus was designed by Mr. W. S. Hadaway.

Another interesting application of electrical heating is shown in Fig. 20, which illustrates a finisher's heater. This device is used to heat the various forming and ironing tools employed in fastening ornamental gilt work on high grade books. In this work the leather covering is heavily embossed with suitably shaped tools, which are heated to a certain temperature. These tools are also used for pressing in the gold leaf in the various ornamentations. In this work it is essential that the tools be heated to the proper temperature, and that they be perfectly clean and free from oxidation and foreign substances of any kind when used. For the purpose of properly heating these tools the electric heater is found very convenient. This stove is 10 ins. in diameter and its two heats furnish temperatures of 300 deg. and 600 deg. F., respectively.

For removing the impression on heavy bond paper the New York Life Insurance Company utilizes a hydraulic press, the pumps of which are worked electrically. These pumps are shown in Fig. 8. They consist of a pair of pumps such as are used on ordinary presses, and to the handles thereof are coupled two long rods which pass two crank discs mounted on a countershaft on the ceiling. To this countershaft is geared a bipolar motor of 3 h.p. capacity.

The New York Life Insurance Company produces from time to time a great many small pamphlets for advertising and for other purposes. These pamphlets are folded by motor-driven folding machines, one of which is shown in Fig. 11. The two machines in the New York Life binding department are driven with motors of ½-h.p. capacity.

The pamphlets are stapled together by electrically driven stapling machines. One of these is shown in Fig. 12, and is driven by 1-6-h.p. motor running at 830 r.p.m.

A device which properly belongs neither

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to the department of printing nor that of binding, but which is interesting, nevertheless, is the ruling machine shown in Fig. 8. This machine rules the policy sheets with a fluid ink by means of pens, and though it is a large machine, it uses but very little power. A 1-6-h.p. motor run at 1600 r.p.m. is sufficient, and is connected to the machine through a worm gear.

In the art of electrotyping, electricity has been ingeniously applied by the New York Life Insurance Company

The routing machine is shown in Fig. 3. It is driven by a motor of ½-h.p. capacity, running at a speed of 1600 r.p.m. The peculiarity of the application of this motor lies in the fact that its shaft is vertical and the bearings and field frame have been redesigned to accommodate this arrangement. The motor is belted by two multiplying belts to the routing tool, which runs at a speed of 12,000 r.p.m.

In Fig. 4 are shown the rough shaver and the beveler. These require 2¼ h.p. respectively. Each has its separate motor. The speed of the motor on the rough shaver is 1000 r.p.m. The beveler has a small motor running at 1300 r.p.m. The smooth shaver requires only a moderate power, the motor having an output of 1 h.p. and a speed of 1000 r.p.m. This machine is shown in Fig. 6.

The little jig saw, shown in Fig. 7, is driven by a ¼-h.p. motor of the Lundell type, manufactured by the Sprague Electric Company. This type of machine is very compact and efficient, and will undoubtedly find many uses among other wood working artisans.

Fig. 2 is devoted to the illustration of the moulding press for making the wax impressions in electrotyping. This machine employs a 2-h.p. motor, running at 813 r.p.m.

These devices are typical of a number of others which are contained in the same department, and each of the various machines, it will be noted, is driven by its own separate motor.

In Fig. 10 is illustrated a little electric elevator used by the Bradstreet Press, which, while not a direct application of electricity to the book producing art, is nevertheless very convenient. It is intended for lowering and raising forms from the composing room to the press room. It is entirely automatic in its action. The pressure of a button on the door jamb starts the elevator up or down and takes the control from all other buttons. The door is automatically locked unless the elevator is directly opposite, and the elevator cannot be started or stopped from any point of contact when the door is open. This elevator is the production of the Sprague Electric Company.

The building in which these extensive equipments are located is a model of its kind. It stands on Elm Street, directly in the rear of the New York Life Insurance Building, and is light, airy, well heated and ventilated, and thoroughly fireproof. The current used for the numerous purposes is generated on the premises by a large Crocker-Wheeler plant which, being standard in design and construction, does not require description. All of the wiring is done in iron-armored conduit.

To the superintendents of the printing departments of the two companies—Mr. W. H. Van Wart, of the New York Life, and Mr. John Oliver, of Bradstreets—much of the credit is due for the completeness of the electric power application and for many of the special features included.

The plants described, having been gradually evolved, contain no experimental features, and are therefore particularly instructive. In fact, as an example of the capabilities of the electric motor we know of no installation comparable with those here noticed.

# The Induction Generator.

## TESTS OF AN INDUCTION GENERATOR.

The principle of reversibility of electrical generators also applies to the induction motor, which, when driven at a speed above synchronism, will act as a generator. In order to do so, however, there must be connected in circuit with it either an alternator or a synchronous motor.

The following tests, described in a paper by Prof. A. F. McKissick before the American Institute of Electrical Engineers, June 29, 1898, were made with a General Electric 5-h.p., three-phase 220-volt, six-pole, 60-cycle induction motor, with starting resistance in secondary rotating element (see Figs. 1, 2 and 3), driven by a 10-h.p. 110-volt Thomson-Houston direct current motor.

The machine used as an alternator and synchronous motor in the tests was an "Ideal" 5-k.w. three-phase, 60-cycle, 10-pole, 220-volt machine (see Fig. 4), and could be belted either to a jack-shaft or to a 3 kw. Edison 125-volt dynamo. The curves in Fig. 5 show the operation of the induction machine as a motor with varying output.

The tests were divided into two series, one with the belt connecting the alternator to the jack-shaft thrown off after starting; in the other the belt was not removed.

In the first series of tests, the belt connecting the Ideal alternator to the jack-shaft was in each case thrown off after starting, and the alternator run as a synchronous motor, either without load or driving the 3-kw. Edison dynamo.

The method of obtaining the magnetization curves shown in Fig. 6 was to start the induction motor from the Ideal alternator, the 10-h.p. direct current motor being belted to the induction machine when up to speed; current was supplied to the 10-h.p. direct current motor, driving induction machine near synchronism, and then the belt thrown off connecting the alternator to the jack-shaft. This alternator then ran as a synchronous motor, receiving its current from the induction machine, which is now driven as a generator by the 10-h.p. direct current motor belted to it.

By varying the exciting field current of the synchronous motor, the voltage of the induction generator is varied, and from the readings of the field current in the synchronous motor and the voltage at the terminals of the induction generator, the curve marked "Induction generator" in Fig. 6 was obtained. The magnetization of the Ideal alternator is also given in Fig. 2, which is almost identical with the magnetization curve of the induction generator.

In a test with the induction generator driving the synchronous motor loaded, the alternator was made to run as a synchronous motor by the induction generator as before, and then belted to the 3-kw. Edison machine, driving it as a dynamo. The results of this test are shown in Fig. 7. In making the calculations for efficiency, the energy required for the excitation of the synchronous motor fields was charged up against the synchronous motor.

Fig. 8 gives the results of the following test: With the connections the same as in the preceding test, and the load on the 3-kw. Edison machine maintained constant, the voltage of the induction generator was varied, and corresponding current, watt and speed readings recorded.

The voltage was varied from 260 to 125, the synchronous motor falling out of step on attempting to lower the voltage to 100. Curve A gives the variations of the supply current with the field current; curve B, the variation of the supply current with the voltage of supply; and curve C is plotted between the power factor and the voltage of supply.

In a test of the induction generator with a lamp load, the induction generator was started as before, and a lamp load that could be varied was put on, it of course being necessary to run the synchronous motor empty. The load in lamps was varied from zero to the full load of the induction generator, with the result shown in Figs. 9 and 10.

In calculating the results shown in Fig. 9, the watts supplied to the alternator running as a motor, and to the lamps, were taken as the output of the induction generator, the efficiency being this output divided by the input to the induction generator; and the power factor, this output divided by the total apparent watts from the induction generator.

In Fig. 10 the fact that the energy delivered to the alternator, and that required for the excitation of the alternator fields, does no useful work is taken into account. So in calculating the results in Fig. 10, the watts supplied to the lamps were considered as the output, the efficiency being this output divided by the input; and the power factor of this output divided by the total apparent watts from the induction generator.

In testing the synchronous operation of the alternator, the speed of the induction generator was varied, the voltage of supply being maintained constant, and corresponding readings of speed taken on the alternator running as a synchronous motor, which showed that motor ran

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in synchronism with the induction generator. The results are shown in Fig. 11, the full line representing the synchronous speed line, the small circles the points found from readings. In this test, and all preceding tests, the belt connecting alternator to jack-shaft was thrown off after the starting up of the induction generator.

In the following tests, the belt connecting the Ideal alternator to the jack-shaft was not removed.

In a test of the induction generator when furnishing current to the alternator, the induction generator was started up as usual, and its speed gradually increased from below synchronism to about six per cent. above synchronism, readings taken as usual. The alternator was therefore run as a motor and helped to drive the jack-shaft.

The results are plotted in Fig. 12, which will be found by comparison to resemble the curves constructed by Mr. Steinmetz. It is interesting to note in connection with this test the readings on the two wattmeters, as shown in Fig. 13.

At the beginning of the test and before the induction motor was speeded up, readings were taken on the two wattmeters, but as the power factor was below 50 per cent., the reading on one wattmeter (No. 2) was negative; hence, its connections had to be reversed, and with its connections thus reversed the difference of the two wattmeter readings represented the total true watts. As soon as current was turned on the shunt motor (insufficient however to make this machine act as a motor and drive the induction machine), the load on the induction motor was decreased, the power factor decreased, and the corresponding wattmeter readings are shown in Fig. 13.

On furnishing sufficient potential to the shunt motor to make it act as a motor and drive the induction motor as a generator, the readings on wattmeter No. 1 diminished and finally became negative (necessitating a changing of its connections), while the readings on wattmeter No. 2 continue to increase as shown, but were always negative. Under these conditions, the total watts were the sum of the two wattmeter readings, and as the sum is negative the induction generator was supplying energy to the Ideal alternator.

A test with the induction generator furnishing current to the Ideal alternator and to a bank of lamps was the same as the preceding one, except that a bank of lamps was connected to the three-phase terminals. At the beginning of the test, the alternator furnished current to both induction motor and lamps, but on speeding up, the induction motor, now running as a generator, supplied current to both lamps and alternator, which latter acted as a motor, helping to drive the jack-shaft.

The results of these tests are shown in Fig. 14. Curve B is plotted with the induction motor output as ordinates and the number of revolutions per minute above synchronism as abscissæ. At first the output is negative, which indicates that the motor was receiving energy from the alternator; at eleven revolutions per minute above synchronism it commenced to act as a generator, and at twenty-two revolutions it furnished energy to both alternator and lamps.

As pointed out by Mr. Steinmetz, the induction generator can be run at different speeds and still the same frequency obtained from it. For proof of this, a small induction motor was connected in the above test to the three-phase mains and run with no load. Variation of the speed of the induction generator from synchronism to 20 per cent above synchronism did not in any way affect the speed of the little induction motor, its speed remaining constant, and almost synchronous with the Ideal alternator. Of course, this will not hold true when the conditions are as described in Fig. 11.

On attempting to make some tests with this induction generator as a single-phase instead of a three-phase machine, it was found that the current required by the motor when running as a synchronous motor (with the belt connecting the alternator to the jack-shaft thrown off), was excessive, so that this test had to be abandoned.

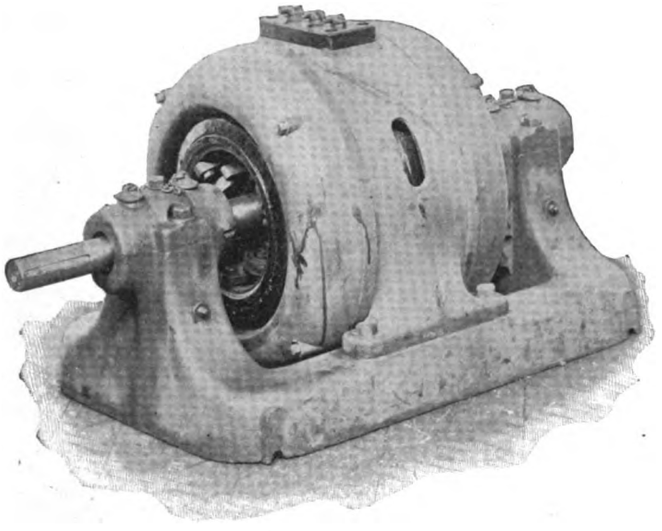


FIG. 1.—5-H.P. INDUCTION MOTOR.

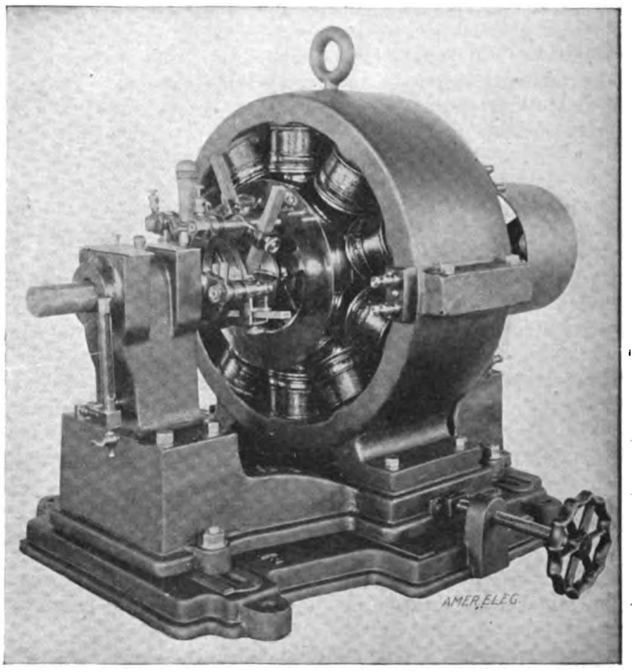



FIG. 4.—5-KW. POLYPHASE GENERATOR.

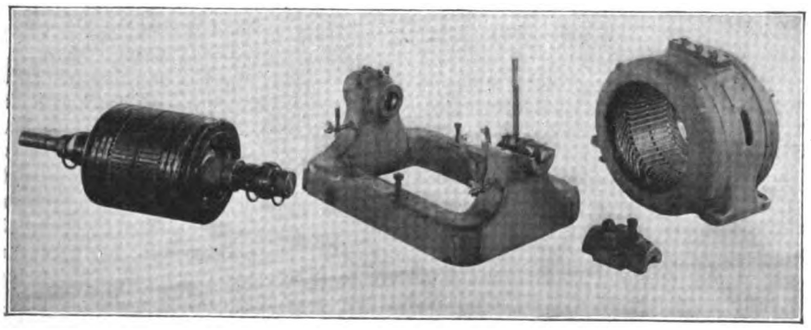


FIG. 2.—PARTS OF INDUCTION MOTOR.

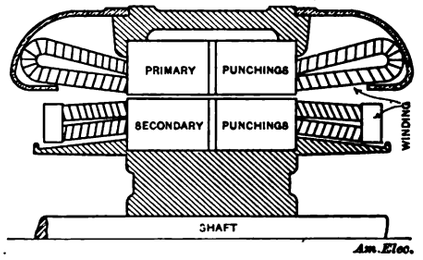



FIG. 3.—DETAILS OF INDUCTION MOTOR.

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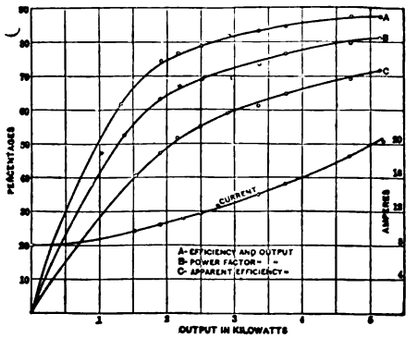



FIG. 5.



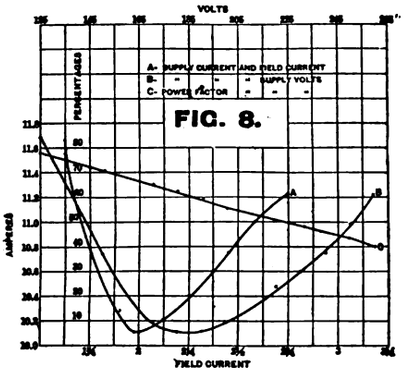




FIG. 8.

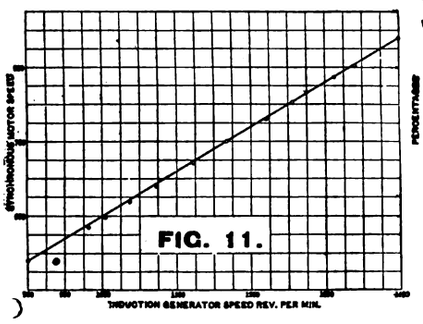



FIG. 11.

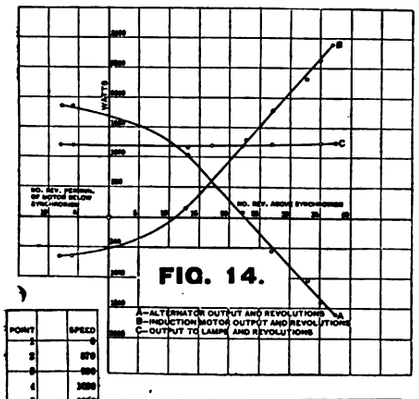



FIG. 14.

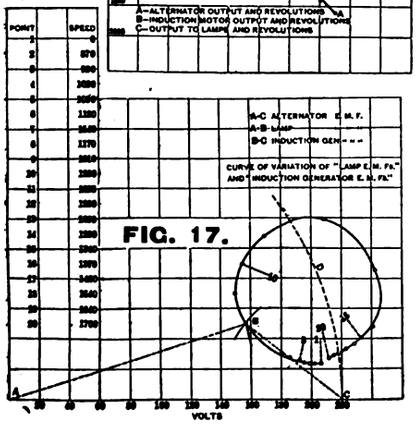



FIG. 17.

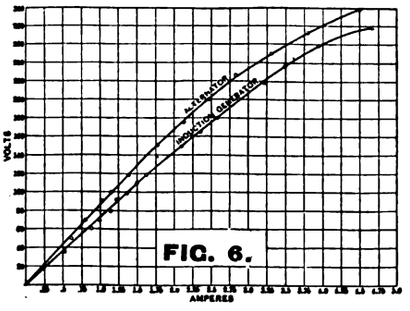



FIG. 6.

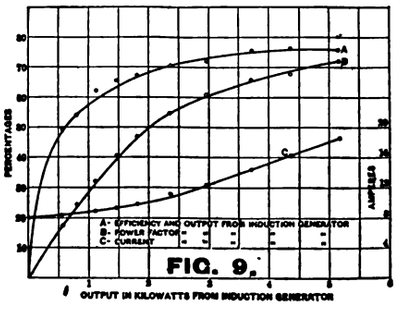



FIG. 9.

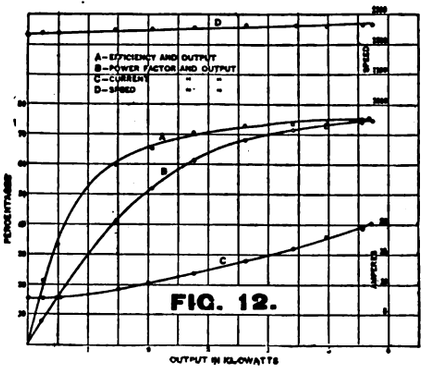



FIG. 12.

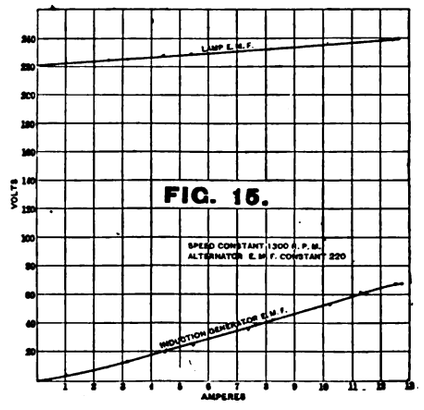



FIG. 15.

FIGS. 5 TO 18.—CURVES FROM EXPERIMENTS.

### USES OF THE INDUCTION GENERATOR.

The most probable use of the induction generator will be for boosting. Mr. Kelly has discovered that an induction generator, having its field coils in series with the mains, will act as a booster or feeder regulator, and that this action as a booster at any particular speed above synchronism will depend upon the amount of current supplied by the field magnets.

In order to use an induction generator

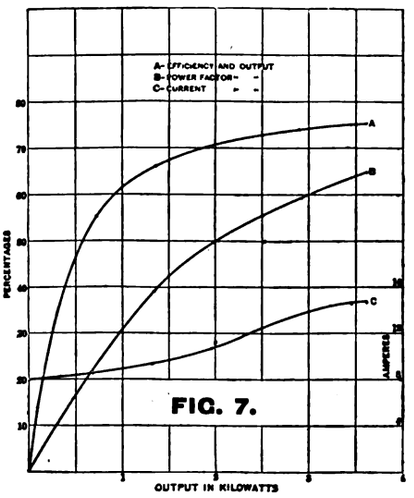



FIG. 7.

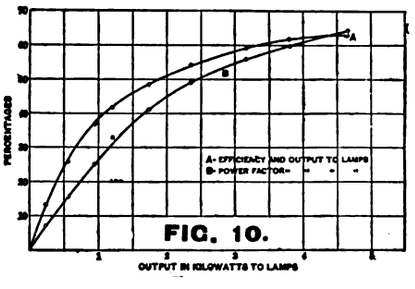



FIG. 10.

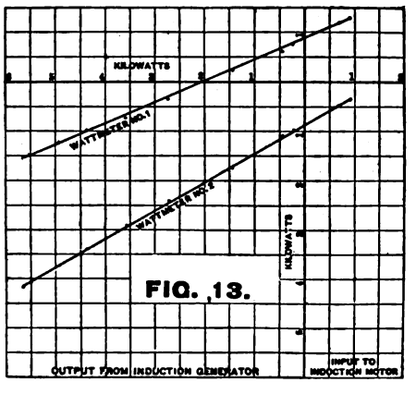



FIG. 13.

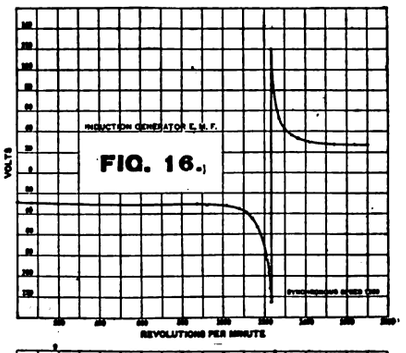



FIG. 16.

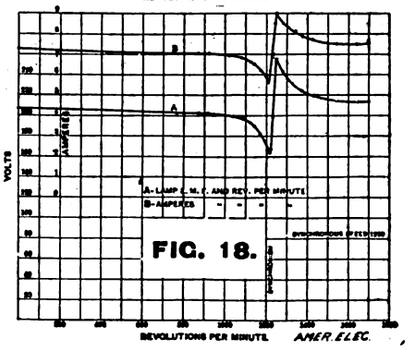



FIG. 18.

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as a booster, the fields are connected in series with the main line, and the induction generator driven above synchronism. With no current flowing, there will be no boosting action, but as soon as current flows the boosting action commences, its amount depending upon the current flowing in the mains, and this amount for a given current may be varied by varying the speed of the induction generator. So that by the use of an induction machine as a booster we get a generator with no brushes, collector rings or commutator.

In case the induction motor should ever be used for the propulsion of street cars, its action as an induction generator, when driven above synchronism, could be taken advantage of in descending grades, thus pumping back energy into the line, and doing away with braking to a great extent.

In a test of the induction generator as a booster, the generator and alternator used in the above experiments were connected in series as single-phase machines, and with a bank of lamps, and readings taken to determine its boosting action.

In the first test as a booster the speed was maintained constant at 1300 revolutions per minute (synchronous speed 1230), and the current flowing in the mains varied from zero to the full load current of the alternator by adding lamps. The results obtained are shown in Fig. 15.

In the second test of the speed of the induction generator was varied between wide limits, the alternator e.m.f. being maintained constant, and also the number of lamps connected in series with the two machines. The results are shown in Figs. 16, 17 and 18.

## AN ELECTRIC PYROMETER.

BY H. L. MUNNOCH.

In order to measure high temperatures numerous pyrometers have been devised at various times more or less adapted for the purpose, the most reliable one in use until a few years ago being the Siemens copper ball pyrometer. In careful hands this pyrometer gives very accurate results, but for many purposes it is inconvenient to use, and the time required is not less than about five minutes when a temperature is taken.

The electric pyrometer here described is generally known as the Chatelier pyrometer, which has many advantages. The results can be read off at any time the same as with a pressure gage, it is reliable and accurate, it will work for years with very little attention as it seldom gets out of order, and it can be adapted for almost any purpose. It has been successfully used in England for indicating the temperature of the blast passing along the hot blast mains into the blast furnace, and I will describe one that has been in use at a Cleveland works for this purpose continuously since 1893 with excellent results.

The pyrometer consists essentially of three parts. (1.) A thermo couple consisting of two wires, one being pure platinum and the other an alloy of platinum with 10 per cent rhodium, this combination being the result of researches of M. le Chatelier. (2.) A mirror galvanometer, preferably of the d'Arsonval type, with lamp and scale. (3.) A copper wire line connecting the thermo couple and galvanometer. The principle of its action is the measurement of the voltage produced by heating the thermo couple.

We have two sets of apparatus, one for the use of the foremen and stovemen, the galvanometer being fixed in an office behind the furnaces, convenient for constant use; the other is a recording apparatus which was designed by Professor Roberts Austen and made by J. Pitkin, London. The former will now be described in detail.

The galvanometer is a Desprez-d'Arsonval, and is placed in a wood case to exclude

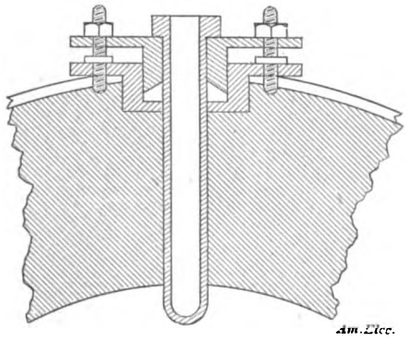



FIG. 1.—RECEPTACLE FOR COUPLE.

dust as much as possible, and the wires of the galvanometer terminate in a plug. There are four furnaces, and for each of these a plug switch is placed close to the galvanometer. A pair of No. 16 insulated wires are run from each switch to the respective furnaces, and these wires are connected to the two wires of the thermo couple. The temperature at either furnace can thus be readily taken.

Fig. 1 shows the arrangement for inserting the couple into the hot blast main, which is a wrought iron tubing lined with 9 ins. of firebrick. A hole about 1 in. in diameter is drilled through the plate and firebrick, and through this a Dresden porcelain tube about 12 ins. long is inserted, the tube being closed at one end and having a collar at the other. As the blast in the main is under pressure, a stuffing box is studded to the iron tubing and a packing of asbestos is used to make the joint tight. The porcelain tube projects about an inch into the main. The platinum and platinum-rhodium wires were at first merely twisted together at the end, but in time the contact between them became poor, which was a source of trouble. In order to overcome this difficulty the wires are now fused together in a flame obtained by blowing an oxygen jet through a spirit lamp flame. The wires are placed in the porcelain tube, and in order to insulate them they are threaded through fireclay cylinders about 3 ins. long, which have fine holes running longitudinally. The cylinders fit loosely into the porcelain tube, and reach nearly to the top, which is closed with an ordinary cork; the couple wires are led through the cork to the outside, where they are connected to the line wires by suitable clamps.

Now when the fused end of the couple is heated, an electric current is generated which varies according to the difference between the temperature of the points of contact and that of the ends joined to the line, and this is shown on the scale of the galvanometer. In order to give the reading a definite nature, the wires require to be standardized, which is done by heating them to several known temperatures and taking the readings on the galvanometer. From these results a definite value in degrees is given to each division on the galvanometer scale.

Before the couple is fixed it is standardized in the laboratory at the following temperatures:

| | Fahrenheit. |
|---|---|
| Boiling point of water | 212 |
| Melting point of tin | 441 |
| Melting point of lead | 618 |
| Boiling point of sulphur | 838 |
| Melting point of aluminum | 1158 |
| Melting point of potassium carbonate | 1592 |
| Melting point of potassium sulphate | 1860 |

The couples are placed in the boiling water and deflection noted. For the tests with tin, lead and aluminum a crucible about 2 ins. high is used, of which Fig. 2 is a section, the wires being placed in the hollow recess at the bottom of the crucible. The metals are melted in an ordinary crucible in a muffle furnace and then poured into the special crucible, the reading of the galvanometer being taken just as the metals are becoming pasty and beginning to set. The sulphur is melted in an iron tube closed at one end and the wires held in the sulphur vapor; this test requires a little care on account of the liability of the vapors to take fire, and should be continued for a little time so as to get a constant reading. The potassium carbonate and sulphate are melted in platinum crucibles, and when they are quite fluid the wires are stirred about in the molten salt until it becomes pasty and begins to set, the reading being then taken.

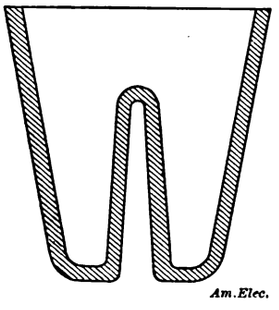



FIG. 2.—TESTING CRUCIBLE.

When taking the readings of the metals and salts it is a peculiarity that the deflection of the galvanometer will remain steady from the time when they begin to set until a minute or two after they are set completely, so that it is easy to get an accurate reading. From the readings thus obtained a scale of temperature is calculated for all the divisions of the galvanometer scale, a copy of which is hung up near the galvanometer. By means of this apparatus temperatures can be taken at any time to within 10 degs. F.

If two lengths of wire are obtained suffi-

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cient for several couples, it will only be necessary to cut off one couple and standardize it, as the others will be the same; but if wire is obtained at different times the new wires should be standardized, as a slight variation in the alloy wire makes a difference in the deflection. A couple originally fixed in September, 1893, was taken out in September, 1898, and on being standardized it gave exactly the same results as when originally tested. The electric pyrometer has frequently been checked with a Siemen's copper ball pyrometer, and almost invariably found to agree within a few degrees.

Besides the special use of this pyrometer which I have just described, it is used for other purposes, such as taking the temperature of molten slags, molten metal and the heat of various kinds of furnaces. In fact, it can be used anywhere if the wires are protected by a fireclay or porcelain tube.

The recording apparatus (Fig. 3) consists of two rectangular light tight boxes. One is 15 ins. long, 7 ins. broad and 10 ins. high, and contains a brass drum (D) about

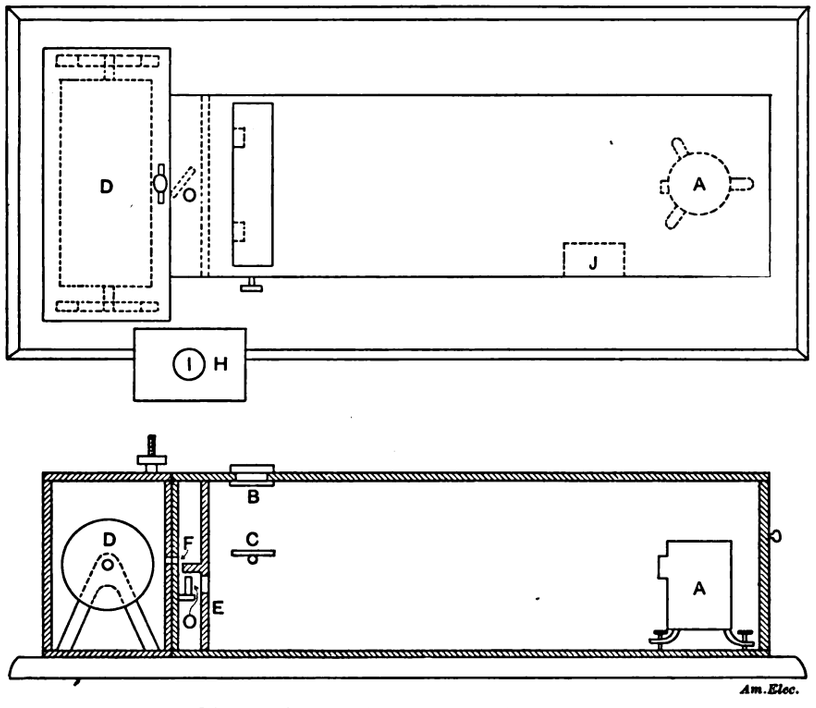



FIG. 3.—PLAN VIEW AND SECTION OF RECORDING APPARATUS.

5 ins. in diameter, around which a sheet of rapid bromide paper, 8 ins. wide and 16 ins. long, is wrapped. The drum is driven by clockwork and makes one revolution in 24 hours. A fine slit (F) is made in one side of the box, and runs horizontally opposite the center of the drum, which slit can be closed by means of a screw on the top of the box.

The other box is 2 ft. 9 ins. long, 10 ins. broad and 10 ins. high, and is mounted on a base board. At one end is placed a 250-turn Holden-d'Arsonval galvanometer (A), and at the other end there is a slit corresponding with that in the box containing the drum. The light for the galvanometer is supplied by a paraffin lamp or gas burner (H), placed at the side of the box near the end containing the slit; the light travels through an aperture in the box half way across, and is there reflected through a narrow vertical slit (E) to the galvanometer mirror (C), whence the narrow vertical beam of light is reflected across the horizontal slit at the other end, and a small spot of light thus passes through to the bromide paper, the position varying according to the deflection of the galvanometer.

Close to the slit in the box there is a plane mirror (O) about one inch wide, extending across the box, and by means of a knob outside this mirror can be turned down so as to intercept the ray of light from the galvanometer and reflect it on to a transparent scale (B), which is let into the top of the box and is closed with a lid when not in use; this scale enables independent readings to be taken any time. The box also contains a clock (J) which acts as a two-way switch by making alternate contacts of a minute duration to two lines, so that records from two furnaces can be obtained at the same time; every hour for one minute there is no contact made with either line and the galvanometer returns to zero, thus giving hour marks on the paper and also a zero mark.

The recording galvanometer is standardized in the manner already described, at the same time taking records of the tests on the bromide paper and readings on the scale on the top of the box. From these results a temperature scale is constructed for the bromide paper and for the scale on the box. After the records are taken on the bromide paper the box containing it is carried to a dark room, a new paper is put on the drum and the apparatus started for another 24 hours' record. The bromide paper taken off is then developed and fixed in the usual way; when the paper is dry it is ruled at the hour marks and also ruled for each 100 degs. of temperature.

Some six years' experience with this electrical pyrometer has proved it to be accurate and reliable if standardized with care, and its application may be termed universal, as with a little ingenuity it can be modified to suit almost any purpose.

## THE CANDLE POWER OF ARC AND INCANDESCENT LAMPS.

### THE DEFINITION OF SOME PHOTOMETRIC TERMS.

BY PROF. WILBUR M. STINE.

Candle Power.—The candle power is a unit for expressing the intensity of light sources and illumination, and is in general use principally in Germany, England and the United States. In France the unit most widely employed is termed the *carcel*.

The origin of the c.p. unit is clearly indicated by its name. In the early days there was no great variation in the size of the molds for making candles, and though there was no apparent design about the matter, yet the result was that there existed comparative uniformity in the character of the materials, size of wick and finished candle.

A candle flame much exceeding 2 ins. in height begins to smoke; consequently the wick would be snuffed before the flame reached the smoking length, and this condition, together with the close resemblance of candles wherever made, insured a greater uniformity of illuminating power from candles than has been obtained from any light source since employed. It is thus readily understood why the candle came into use as a simple concrete unit of light when people began to compare illuminations and the intensities of light sources.

Accordingly, to-day, we speak of the light of an incandescent lamp being a certain c.p. But this adherence to the use of an obsolete term has more to commend it than the use of the foot as a unit of length; for, though in the metric system we have a unit much superior to the foot, there is really no photometric unit to displace the candle.

The English Candle.—The specifications for this standard are a wick of three strands, having eighteen to twenty-one threads to the strand. (Note that nothing is said about the size of the threads, one of the many uncertainties connected with this standard.) The material of the candle is spermaceti. The finished candle is 10 ins. long and has a diameter at the top of 0.8 ins. and at the bottom 0.9 ins., and its weight is six candles to the pound. The wick must be of such a character that with the flame of normal height the candle shall consume 120 grains of material, wick and spermaceti, per hour. Should the weight of material consumed be greater or less than that just given, the amount of light emitted by the candle will vary within certain limits, proportionately.

When burning under normal atmospheric conditions, with clean wick and a flame-height of 1.8 ins., such a candle is

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supposed to emit unit intensity of light, or 1 c.p.

However precise these specifications may appear, when one comes to practice with such a unit, he is reminded of the description of a certain length-standard in the London Exchecquer, which was broken on an occasion and repaired by riveting, so carelessly, that the parts had as much play about the joint as a blacksmith's tongs.

It is to be noted that a candle is supposed to give unit light when the flame has a height of 1.8 ins., and careful tests show that a change of even 1-10-in. from this height may alter the intensity of the light by 3 to 5 per cent. One of the things a candle does not do is to burn with a constant length of flame, so that readings with it can be made only at such time when the proper flame height is indicated.

A candle flame is sensitive to the slightest air current, and as its readings are valueless unless the flame is perfectly steady, every precaution must be taken against disturbing the air about the flame. This condition is trying, for even a slight movement of the arm a few feet distant will distort the flame. In fact, it is almost impossible to maintain the air about the candle so undisturbed, that the flame will be perfectly steady. Then too, the candle wick untwisting as it burns, adds its disturbance to the flame. All open flames are sensitive to air currents, but the candle flame is especially unstable from the added effects of the burning of the wick, and the continual change in the height of the flame.

Other sources of uncertainty of the value of the light are the character of the wick and the quality of the spermaceti. The care with which the cotton has been cleaned from which the wick is woven, and the tightness of the stranding are not without influence on the amount of light. The degree of purity of the spermaceti affects the flame very considerably. The barometric pressure and the amount of moisture in the air have, too, a marked influence; increase of pressure makes the flame more luminous, while increase of moisture in the air lowers the amount of light emitted. Practically none of these causes of variation can be removed. It will not do to place a box about the candle flame, nor enclose it with a chimney. In either case the light is uncertainly affected.

When using a candle in photometric work, at least two observers are needed, one to observe the flame height and the other to adjust the screen. The length of flame should be observed through a telescope. Before making a measurement the wick should be cleaned and trimmed; then as the flame steadies and increases in length, at the moment it reaches 1.8 ins., the screen is adjusted and its position read off. Unless the screen is handled dexterously, scarcely more than one reliable reading can be made without retrimming the wick.

The German Candle.—In Germany the Gas-Lighting Association early gave close attention to the specifications for a standard candle. Their specifications are very minute, and the manufacture of the candles is done under their supervision. With such care the German candle (Vereinskerze) is probably more reliable than the English candle. It differs but slightly from the English standard in its dimensions, but is made from a different material, paraffine. The height of the flame taken for unit illuminating power is 2 ins.

The light-value of the German candle in terms of the English candle, if *two uncertainties* can be spoken of as being in *constant ratio*, is, say, one German candle equals 1.15 English candles. One practical application is to note that German incandescent lamps are usually marked in "Kerzen." Thus, "10 K" means 10 German c.p., which is equal to 1.15 English c.p.

In succeeding articles the photometric measurement of the arc and incandescent will be considered.

# Among our Foreign Contemporaries

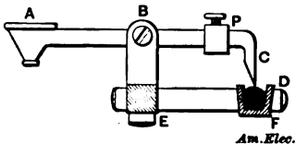
Edited by CHARLES T. CHILD

**Modified Bunsen Cells.**—According to "Engineering," Mr. Emil Petersen has devised some promising modifications of the Bunsen cell. The original form of this battery is well known to consist of an outer zinc element, in dilute sulphuric acid, and an inner carbon element in a porous cup containing strong nitric acid. The sulphuric acid may be replaced by a solution of common salt, in which case neither the e.m.f. nor the internal resistance is affected, and the zinc need not be amalgamated. Several depolarizing agents, such as potassium permanganate, hydrogen peroxide, etc., actually give a higher e.m.f. than nitric acid, but have an insufficient constancy and yield of current.

Mr. Petersen discovered that chloride of iron answered the purpose admirably. Cells made with the zinc in a solution of common salt and the carbon in chloride of iron have all the good properties of Leclanché cells. The e.m.f. is 1.72 volts and the internal resistance of ordinary sized cells from 0.3 to 0.4 ohms. The same arrangement, using an iron plate instead of the carbon plate, yielded for 72 hours a constant current of 1.2 amps. at 0.54 volts.

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**Electric Oil-Shortage Alarm.**—An ingenious little instrument for giving warning of the failure of a steady supply of oil to a bearing or journal is described in "L'Electricien," by M. Aliamet. The accompanying illustration shows its construction very distinctly. A B C is a lever, pivoted at the point B, and carrying at A a little funnel provided with a small orifice; this is mounted directly over the bearing which is to be oiled, and into it drips the oil, from an ordinary sight-feed cup. The size of the outlet hole in the funnel and the regulator of the oil cup are so proportioned that when everything is working normally the funnel is kept partly filled with oil, which drops into it from above and out below into the bearing. If the oil cup is clogged, or empty, the oil in the funnel will run out in a few moments, and the counterbalance P, will cause the lever to deflect so that the point C will plunge into mercury




ELECTRIC ALARM FOR OIL-SHORTAGE.

contained in the insulating cup D, thus closing a circuit connected with an annunciator and bell.

The apparatus is so simple that something on the same principle may be made in any shop, and it seems that it should be reliable and not apt to get out of order.

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**Electrolytic Production of Bleaching Solutions.**—Electrolysis plays an important part in Germany in the preparation of bleaching solutions, says the (London) "Electrical Engineer," especially those for bleaching finer goods. In former days, when solution of chloride of lime found exclusive employment for this purpose, the most careful mixing with water gave imperfect results, since particles of the chloride were liable to remain undissolved, and, being retained by the material to be bleached, gave rise to blemishes and even to holes in it. The electrically-prepared bleaching-lye is, however, quite free from this defect. By subjecting a solution of ordinary salt to the action of the electric current a perfectly clean bleaching fluid of any desired strength, containing no corrosive spots in suspension, may be obtained. Uniformity and freedom from blemishes are thus secured, even if the material to be bleached is not carefully handled during the process.

Another advantage, generally overlooked, is that a solution of any strength, even so strong as to be injurious to the fabric, may be made from bleaching powder, but it is impossible by the electric process to make solutions of harmful intensity. The latest method for producing these solutions, which comes from Germany, is to use no metal for electrodes at all, save at the cathode end of the apparatus.

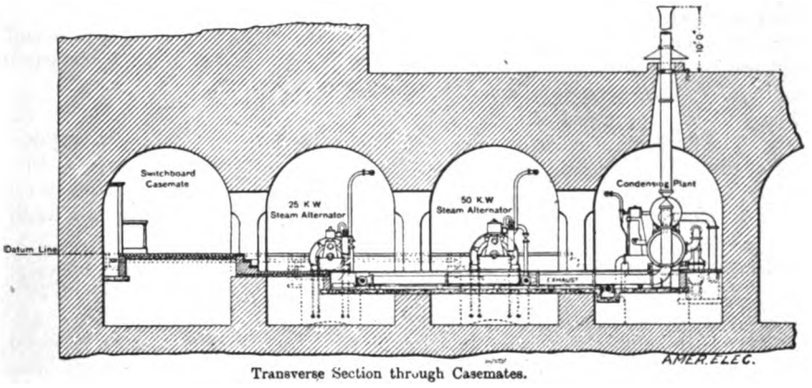
The tank consists of a single wooden box, containing grooves in its sides, into which are slid the specially prepared electrodes. Current is fed only to the end electrodes, the others acting bi-polar fashion, one side as anode and the other as cathode. In this way the number of elements in series may be so increased that the current from ordinary dynamos used for lighting by night may be used to electrolyze salt water by day. Under a pressure of from 65 to 110 volts, it is possible

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to prepare 100 cu. ft. of bleaching-lye from 300 or 400 lbs. of salt in ten hours.

**The Electric Lighting of Gibraltar.** —The famous fortification of the Rock of Gibraltar has been provided with a modern electric light station, which was installed under some curious difficulties due to the extraordinary location on which it was necessary to place it. The site of the station, which is very fully described and illustrated in the "Electrician," is what is known as the King's Bastion. This was originally an artillery barracks, and was built in the solid rock. The accompanying illustration shows how the old casemates of the fortification were utilized for the installation of electrical machinery. There is nothing especially remarkable about the electrical installation itself, which consists of three locomotive boilers and four Siemen's alternators, direct connected to Belliss engines. The distribution is effected at 2000 volts, single-phase, and the ordinary 110-volt, two-wire secondary for incandescent lighting. Street lighting in the town is from a 220-volt, three-wire network, mostly incandescent lights being used for this purpose. The condensing plant was extremely difficult to install. Water for the condenser circulation was obtained from the sea, the suction and ejection pipes having been passed through brick work 12 ft. thick and thence 100 yds. out to the water. Of course, the condensers are of the surface pattern, and are supplemented by an evaporator plant to make up losses in the feed water. Another peculiarity of the plant is that the whole of the mains throughout the system consist of concentric cables. The insulation is bitumenized fibre and the cables are lead-sheathed and further protected by coatings of hemp and steel tapes. They are laid directly in the ground, under the sidewalks. Five substations are connected to the high tension mains, and supply the two-wire and three-wire systems for general supply and street lighting respectively. The incandescent street lamps are arranged alternately on opposite sides of the three-wire circuit, and at midnight switches in the sub-stations are thrown so as to cut out one side of each circuit.

The plant is not a very large one, but there is probably no other electric light plant installed in casemates cut in the solid rock.




SECTION THROUGH CASEMATES, GIBRALTAR ELECTRIC LIGHT STATION.

**Wireless Telegraphy.** — M. Albert Nodon, writing in "L'Electricien," rather criticises the Zickler system of wireless telegraphy, described in these columns in the October, 1898, number, in which ultra-violet light is used to increase the conductivity of a vacuum-tube at the receiving station. The principal objection, according to M. Nodon, to this system is that the very short radiations of the ultra-violet light are readily absorbed by water-vapor, and even by the atmosphere itself. Experiments made by the author at the Meudon observatory demonstrated that the short wave-length radiations of the electric arc were readily absorbed by thick layers of air, a fact already well known in connection with solar and other radiation. He suggests that instead of utilizing the short radiations of violet light, long radiations, or so-called radiant heat, would form a far more satisfactory medium for this variety of communication. It is already known that the relatively long Hertz waves readily traverse not only air and water-vapor, but the greater majority of solid and liquid bodies as well. The obscure rays of intermediate wave-length between these and visible light have equally the property of easily traversing atmosphere charged with water-vapor and dust. For the reception of signals sent by such a method, either a sensitive thermopile or a bolometer, which consists of an extremely thin platinum wire whose electrical resistances is minutely affected by temperature changes, may be used.

This suggestion is interesting in two ways; not only as showing the ingenuity of its author, but also as a specimen of the many utterly impracticable schemes that have been suggested by the widespread interest in wireless telegraphy. Contrary to the author's assumption, the radiations of hot bodies, not necessarily luminous, are readily stopped by moist air, while the instruments that he proposes as receivers are almost unmanageably sensitive, and can only work to any advantage under the most refined conditions of the laboratory.

**A Phase Comparator.**—An ingenious modification of the ordinary phase lamp arrangement, used for paralleling alternators, is described in "L'Electricien." The illustration herewith is a schematic diagram of the arrangement utilized for connecting three-phase dynamos in parallel. The dynamos are shown at the bottom of the drawing, and, for the sake of simplicity, the connections from only one of them are indicated. These are led through the circular three-point switches, shown at the right and left of the diagram, to three phase-lamps and to volt meters. The three lamps, $L_1$, $L_2$ and $L_3$, are so connected by means of the switches, A and B, that they are bridged across points of the armature windings of the two machines having a simple cyclical order, readily understood by reference to the diagram, but exceedingly difficult to explain in

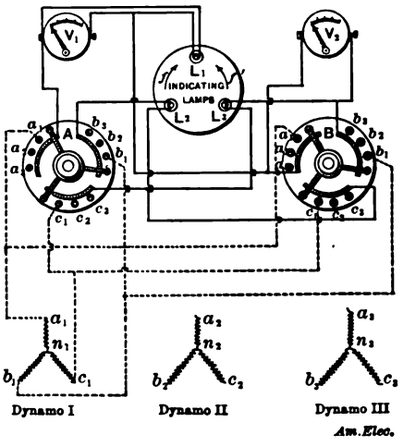


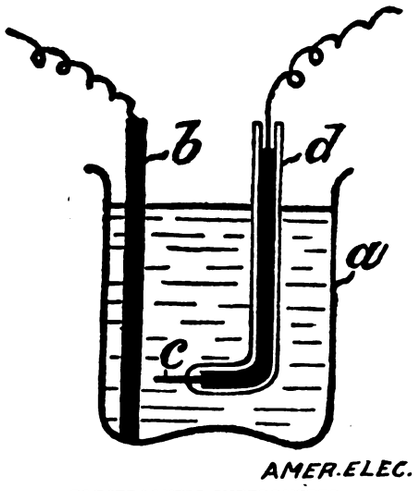

DIAGRAM OF PHASE COMPARATOR.

words. Under these conditions, if the two machines to be connected are not in exact synchronism, the phase lamps will be lit and extinguished in the usual way, but in regular cyclical order. A round sheet of ground glass is mounted over the three lamps, and if the machines, when it is desirable to parallel them, are not in precise synchronism, the light due to the rapid illumination and extinction of the three lamps in order, will appear to run circularly, in one way or the other, around the ground glass. According to the direction of its rotation it is determined whether the incoming machine is running too fast or too slow, and the necessary regulation of its speed is made until the rotation of the light becomes very slow, about once in four or five seconds. When this partial synchronism is reached, the machines are thrown together at the instant when the upper lamp, $L_1$, is entirely extinguished. The intervention of the switches A and B is simply to connect together any running and incoming machine and the phase-lamps. This arrangement possesses points of considerable merit, not the least being its remarkable simplicity and ease of operation.

**Induction Coil Interrupter.** — It would appear from an article by Dr. Wehnelt in the "Elektrotechnische Zeitschrift" that an ideal interrupter for the induction coil has at last been realized, and in a most inexpensive form. The device consists merely of a glass receptacle. a, containing dilute sulphuric acid, in which is immersed a lead or other metal plate, b, and a platinum wire, c, fused in a glass tube, d, filled with mercury to conduct the current.

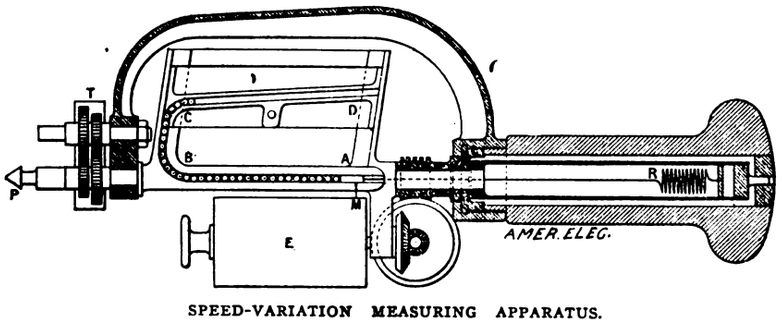
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By connecting this device in the circuit of the secondary of an induction coil it acted as a remarkably perfect interrupter, giving quick breaks of great frequency; frequencies were measured ranging from 200 to 1700 per second. With this interrupter an induction coil does not require a condenser, and instead of inductance in the primary being a detriment it is an advantage, actually favoring the sharpness of breaks. The platinum electrode should be connected to the positive side of the battery or line, as it will be melted if connected to the negative side. It was found that by its means a 12-in. coil would have the spark increased to almost 24 ins., and that a 6-in. coil could be used with a Roentgen ray tube designed for a 12-in. coil. The interrupter gives admirable results in Roentgen- ray work, there being no flickering on the fluorescent screen, and the time for photographing is reduced. From the description, a voltage of at least 12 would appear necessary for good working.



ELECTROLYTIC INTERRUPTER.

**Apparatus for Registering Speed Variations.**—At a recent meeting of the Société Internationale des Electriciens, M. Boucherot, in the course of a paper upon speed and torque curves of polyphase motors, described a highly ingenious instrument for measuring variations of speed. The illustration herewith is a cross-section showing the working parts. The instrument is used like the ordinary speed-counter, by being thrust into the center-mark on the end of the motor bearing. Centrifugal force is made use of, as in the ordinary tachometer, to measure the speed, but instead of utilizing any time-measuring device to obtain the ordinate of the curve drawn by it, the actual rotations of the machine itself are used to drive the cylinder E, shown at the lower part of the illustration.



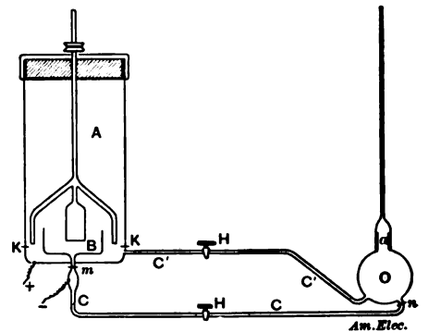
SPEED-VARIATION MEASURING APPARATUS.

A roller-chain is encased in a run-way in the middle of the apparatus, one end of it being attached to the spring R, in the handle. The part of the chain B C, is, of course, subject to centrifugal force when the machine rotates, and runs over into the run-way C D, pulling up the part of the chain A B, and extending the spring. The inclination given to C D is just sufficient to compensate for the friction of the chain against the walls of the run-way. It will be seen from this that the extension of the spring is almost strictly proportional to the square of the speed. The cylinder E is turned by the worm and bevel gear shown in the illustration and a pointer, M, traces upon it a curve, of which the ordinates are angular distance traversed and the abscissæ are proportional to the squares of the speeds.

The results which can be obtained with a machine of this character are very interesting. Among others, the author quotes some speed tests upon a Corliss engine, to note the variations in its speed and the relation of the maxima of speeds to the point of admission of steam and cut-off—results which would have been extremely difficult to obtain by any ordinary method of calculation.

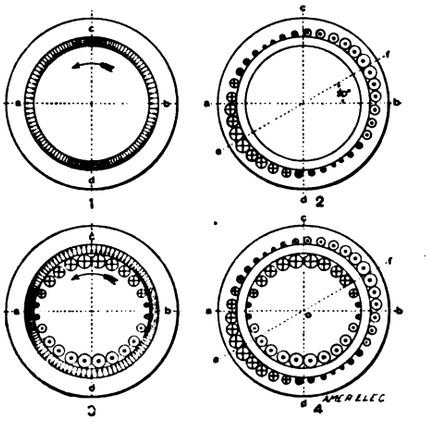
**A New Mercury Voltameter.**—In "L'Electricien," M. L. Gourwitch describes a novel and ingenious form of a voltameter which can be made practically a direct reading instrument, and which is free from most of the difficulties inherent in the ordinary silver, copper or hydrogen instruments. The illustration shows the essential parts of the instrument.

A glass vessel, A, is provided with a 3-pronged agitator coming down through its lid, and has one of the leading-in wires sealed in its bottom. Into this vessel projects a small dish, B, also of glass, connected with the capillary tube c c, and the bulb O. This bulb is also connected by another capillary tube, c' c', with the vessel A. In the outlet tube, below the bottom of the large vessel, is blown a small enlargement, m, into which is sealed the other leading-in wire. The whole apparatus is mounted on a board (not shown in the illustration), provided with screws, so that its level can be properly altered. Mercury is poured into the apparatus until it stands at the level K K in the outer vessel and at an equal level in the inner dish B, and is then allowed to run into the bulb O through the stop cocks shown in the two small tubes. Above the level of the mercury in the bulb colored alcohol is placed, and this is allowed to extend some distance up the capillary tube shown at the right of the illustration. Into the vessel A is put a quantity of water, containing 5 per cent of nitrate of mercury and 10 per cent of nitrate of potassium; the stop cocks are then closed and current allowed to flow through the apparatus in such a way that the mercury in the dish B is the cathode. The natural result is that the quantity of mercury in this dish is increased at the expense of that in the outer vessel, and upon the completion of the operation an opening of the stop cock in the lower tube allows the excess to run into the bulb O and force the colored alcohol up the capillary tube. This may be graduated to read directly in ampere hours or coulombs. It is said that the fall of e.m.f. through the apparatus is only 0.2 volt.



SKETCH ELEVATION OF MERCURY VOLTAMETER.

**Induction Motor Diagrams.**—The graphics of induction motors have always been more or less difficult. Some suggestions contained in an article by Mr. C. C. Hawkins, in the "Electrician," are extremely elegant. Four of his proposed diagrams are here reproduced. They are intended to represent load diagrams when magnetic leakage is absent.



FIGS. 1, 2, 3 AND 4.—INDUCTION MOTOR DIAGRAMS.

Fig. 1 represents a resultant two-pole field, such as would exist in an induction motor at any moment as it rotates in the

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direction shown by the arrow. Then the instantaneous currents induced in a squirrel-cage armature are as shown in Fig. 3, where the relative strength of the currents at different positions are indicated by the size of the circles. The secondary ampere-turns so produced, would, if acting alone, produce a magnetic field, of which the line of maximum induction *a b* (Fig. 3) would be at right angles to the line at maximum induction *c d* of the resultant field at the same moment.

Fig. 2 shows the general disposition of primary ampere-turns which must be produced by the several phases of current in the field winding. Fig. 4 represents both sets of ampere-turns filled in, or a combination of those shown in Figs. 2 and 3.

These diagrams are interesting on several accounts. If properly printed on circular card sheets, so that they could be superposed, they would unquestionably afford a very satisfactory assistance in understanding many problems connected with induction motors.

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**Mixed Traction Tramways in Paris.**—An interesting paper was read by M. de-Marchéna before the Société Internationale des Electriciens, upon the tramline running between Paris, Pantin and Aubervilliers. This line is the first in France to be equipped with a mixed trolley and accumulator system, and its operation, while appearing to also furnish an elegant solution for the difficulties encountered by electric tramways in Paris, is exceedingly interesting from many points of view.

The total length of the line is about 7½ miles, of which about 5½ miles are within the city limits. There is a secondary feeder system comprising about 3 miles, entirely outside the city limits, on which the trolley alone is used. Grades as high as 3.3 per cent are encountered on the part operated by accumulators, and these are unfortunately so situated that their ascent is made when the accumulators have already been partly discharged by use on other parts of the tracks.

It was decided from the beginning not to attempt to remove the accumulators from the cars at any point, but to charge them while the cars were running on the trolley part of the line and to discharge them in the city on those portions of the tracks where the municipal regulations forbade overhead wires.

The equipment of the cars consists of 224 cells upon each, carried in a special box swung under the body of the car, and carefully ventilated to avoid any fumes entering the vehicle itself. Each element weighs 28½ lbs. and contains four negative and three positive plates. The total weight of the batteries, including their box and connections, is 8,386 lbs. The cells are permanently connected in series, all of the joints being burned together. The positive plates are of the usual "grid" type, with composition pellets, while the negative plates are of the chloride type. Double truck cars are used, the trucks being of the "maximum traction" variety. The cars in running order, without passengers, weigh about 10 tons, two 25-h.p. motors being used on each. Including the seats on the roof (an arrangement very usual in France, and which would be highly desirable in this country), the vehicle seats fifty-six people. The track is solidly built of 90-lb. girder rails.

There is nothing unusual about the power stations requiring description. The charge of the batteries for each run is made during about thirty minutes, while the car is on the trolley section. When the car first enters this section the current taken by the accumulators ranges from 80 to 100 amps., falling in about five minutes to 60 amps., and running down gradually to about 20 amps. As the power station is at the end of the trolley line opposite to that at which the cars enter, the conditions for charging are very favorable, the voltage gradually increasing as the car nears the station. Some remarkable results are claimed for the total energy consumption of the road at the power station. For an average of three months the watt-hours generated per car-mile run were only 1,828. About one-third of the car-miles were run on the trolley section, without the intervention of the accumulators. It is stated that an efficiency as high as 60 per cent between the terminals of the dynamos and motors has been attained on this system, but that it may easily fall below 50 per cent if the batteries are allowed to get into bad condition. It is thought that it would be well to augment the weight of the batteries carried on each car, despite the increase of total dead weight which this would entail, on account of being able to obtain in this way a more satisfactory regulation of charge and discharge for the cells. The whole installation, however, furnishes an extremely interesting experience, and in spite of the inevitable troubles encountered by a system of this revolutionary character, its results have been very satisfactory to its promotors.

The conditions of electric traction at Paris are very difficult. To be of any public service the lines must run from central points to the suburbs, but an iron-clad municipal regulation absolutely forbids the use of the overhead trolley within the fortifications, that is, the city limits. The new line now under construction between the Place de la Bastile and Charenton has undertaken to solve this problem by the use of a conduit, very much like those in New York city, at the city end, and overhead trolley in the outskirts. The completion and operation of this line will furnish a valuable comparison with the method described above. It seems reasonable to suppose that in cities where the streets are nearly level, this mixed trolley and accumulator system, already in highly successful operation in Germany, may prove a more satisfactory solution of these problems imposed by municipal governments than even the conduit. The British Isles and the continent of Europe at present furnish a very large field for the exploitation of systems of this character.

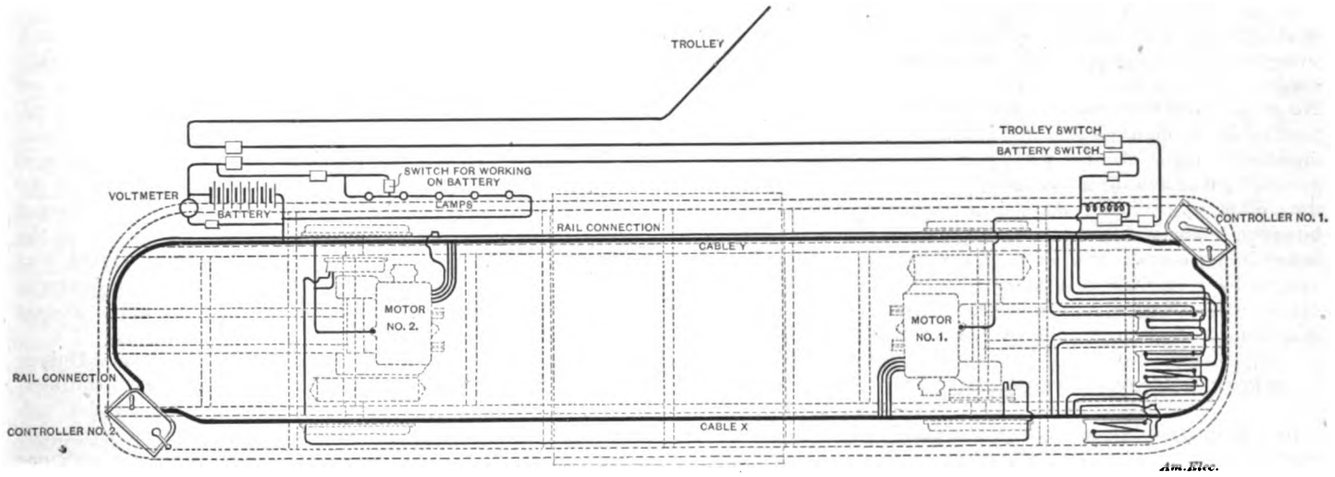



DIAGRAM OF CIRCUITS ON ACCUMULATOR TROLLEY CAR.

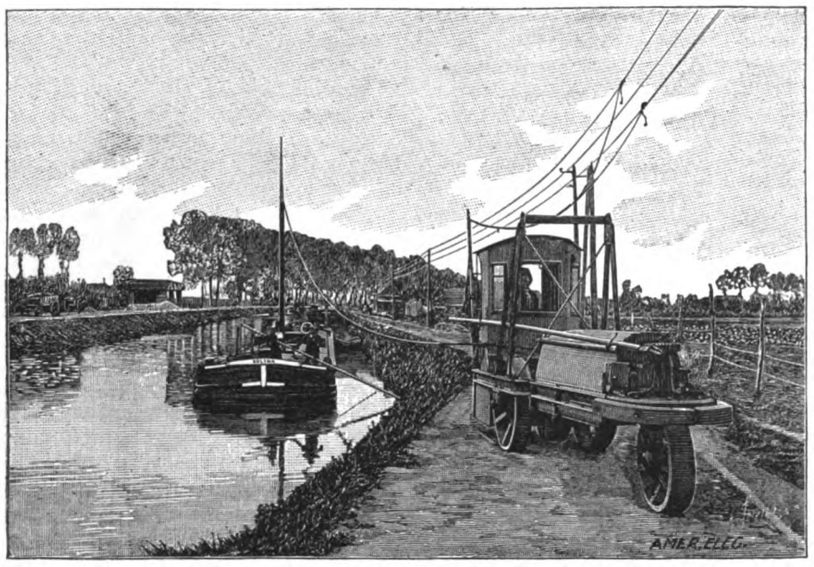
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**Electric Towage on Canals.**—Some very interesting work has recently been done upon the canals between Bethune and Pont-à-Vendin, in the north of France, in the way of electric towage of canal boats. The method used is excellently illustrated in the accompanying engraving, taken from "La Nature."

It was desirable to neither encumber the tow-path of these canals with cross-ties and rails, or any other structure over which the familiar tow-horse could not readily pass,

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and in other ways to approach as nearly as possible the conditions of horse-towage with the new apparatus. The tractor is a variety of tricycle, or road locomotive, having broad tires and a sufficient weight to give it the necessary adherence to the tow-road. A two-pole series motor of about 6 kw. is used, geared to the rear wheels while the machine is steered by the front wheel. The generating stations are situated at points about 9 miles apart along



ELECTRIC TOW-HORSE ON A FRENCH CANAL.

the path; the total distance over which this system is in operation being 50 miles.

As the illustration very clearly shows, a double-trolley wire system is used, and over-running trolleys are hauled along behind this electric horse by flexible cables. No attempt has been made in this installation to attain high speeds, the apparatus crawling along at about 2 miles per hour, at which speed it hauls a boat carrying 185 tons of freight. Under these conditions, however, it almost doubles the speed of the horse-drawn boats. The experiments are said to have resulted in a most excellent economic showing, as well as in great success from a commercial point of view.

## ELECTRICITY DIRECT FROM COAL.

In a paper read before the recent annual meeting of the Northwestern Electrical Association, Prof. A. J. Rogers gave an interesting review of authoritative investigations made to date in the endeavor to obtain electrical energy direct from coal, or, more generally, from carbon and some of its compounds.

Early attempts were made to get a practical carbon battery by using a rod of carbon dipping into a vessel of molten nitrate of potash or other powerful oxidizing agent. As early as 1855 Becquerel had used various molten electrolytes with carbon as an electrode and a platinum dish as a containing vessel and serving as the other electrode.

In 1877 Jablochkoff procured a patent on the use of a solid electrolyte in a state of fusion which would act upon a carbon electrode. Thomson, Edison and others proposed practically the same method. In 1882 J. A. Davis proposed to infuse air into the electrolyte, and in 1883 A. M. Clarke used potash or soda hydrate regenerated with air.

A cell by C. S. Bradley had a fused electrolyte of $Na_2 Mn O_4$ contained in an iron vessel serving as the negative electrode and a carbon rod dipping nearly to the bottom of the liquid mass, as the other electrode. With an iron pot at a red heat it is stated that an e.m.f. of 1 volt and 3 amps. was given by 1 cell. In attempting to verify these results, Prof. Rogers could only obtain from .1 to .2 of a volt, and this did not materially change by the addition of a blast of air. The same voltage can be obtained even when the carbon rod touches the bottom of the iron pot, seeming to indicate a thermoelectric rather than an electrochemical action.

In June, 1894, Prof. Ostwald proposed an ideal carbon monoxide (CO) consuming cell. He proposed the use of an outer copper containing vessel which should serve as an anode. Within this vessel is a porous cup containing the carbon cathode with lumps of carbon. Surrounding the porous cup is a saturated solution of copper chloride, and a constant supply of carbon monoxide is forced into the solution and absorbed by it. A stream of air is also supplied to the cathode compartment.

Following out this line of investigation Dr. Borchers, some five years ago, undertook a series of experiments, using carbon monoxide and air in an electrolyte of copper chloride, which readily absorbs oxygen and carbon monoxide. Since the heat energy of the latter with oxygen is 75 per cent of the told energy of the two, if the gases can be caused to combine either directly or indirectly, setting free electrical energy instead of heat, a tremendous step would be gained.

Borchers thought he had accomplished the desired result. He claimed to obtain as high as 27 per cent of the calculated energy of combination of the two gases to form carbonic acid gas, and with gas from bituminous coal he obtained as high as .64 amps. on short circuit, and .56 volts on high resistance with his apparatus, giving an efficiency of 38 per cent. Many experimenters, including C. J. Reed in this country, H. H. Barnes, E. Vesemmeyer of Stuttgart, Rhodin of Manchester, Eng.; Robert Mond, William Tatlow and others have repeated Borcher's experiments, varying his conditions and criticizing his results. They consider the e.m.f. as due not to the union of carbon monoxide and carbon, but rather as the result of the oxidation of the copper and the copper chloride.

In July, 1897, Borchers read a paper before the Electrical Society of Germany, in which he claims that he has eliminated all sources of error in his carbon element. By the use of glass plates instead of porous diaphrams, he separates the copper and copper chlorides and prevents diffusion. These glass plates extend into mercury, covering the bottom of the cell. The electrodes are made to receive in the carbon monoxide, and in the copper chloride to absorb the former in the best possible manner. By using plates of lead peroxide or manganese peroxide, instead of metal he obtained an e.m.f. of .5 volts.

Since it is still questioned whether Borcher's experiments are conclusive that an e.m.f. is possible with carbon monoxide and oxygen, Prof. Rogers strongly heated two like plates of carbon in an oven, then immersed one of the plates and allowed it to cool in an atmosphere of carbon monoxide, the other remaining in air. After cooling they were partially immersed in a vessel of ordinary lake water, and the e.m.f. noted was as high as .4 volt. The experiment was also repeated, using a dilute solution of sulphuric acid, with similar results except that the e.m.f. would more rapidly diminish, probably from decreased internal resistance. The direction of the current was from the monoxide charged plate through the external circuit to the oxygen or air plate. To what extent, if at all, the copper chloride acts as a conveyor of monoxide to oxygen, Prof. Rogers thinks is still a matter of doubt.

As early as 1883 Carl Hering and Dobrowolsky reported having obtained considerable current with carbon electrodes, sulphuric acid being used as an electrolyte and coal gas brought in contact with one plate and air with the other.

As an aid and a guide to experimental investigation it would seem to be desirable to determine if the element carbon can exist in an electrolyte in the ionic state. With this end in view, Dr. Alfred Koehne has attempted to show that carbon does form ions and, therefore, it is theoretically possible to oxidize the element at ordinary temperatures and obtain electrical energy instead of heat.

He used pure carbon as anode, hot sulphuric acid as electrolyte and platinum as cathode. The liquid became yellow, then dark brown and black, and a thin layer of graphite was deposited on the cathode. Using carbon and lead peroxide as elec-

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trodes and hot sulphuric acid as electrolyte, he obtained a galvanic cell giving an e.m.f. of 1 volt on a resistance of 100 ohms.

Bartoli and Pasogli had previously found that using sulphuric as an electrolyte and carbon electrodes, carbon monoxide, dioxide and oxygen formed at the anode. Of these Koehne obtained 29 per cent, 70 per cent and 1 per cent, respectively.

Franz Vogel thinks that Koehne did not obtain carbon in solution, that deposited being of mechanical and not electrochemical origin. So it is, perhaps, hardly yet proven that carbon does form from free ions in electrolytes at ordinary temperatures. If it does not, the field for investigation in this direction would not seem promising of great practical results.

Within the last few years experimenters have returned again to the fused electrolyte for the carbon consuming cell. W. W. Jacques employs fused caustic soda as the electrolyte contained in an iron melting-pot. This vessel also serves as an electrode. Air is admitted at the bottom of the iron vessel and mixes with the carbon electrode suspended in the liquid. Carbonic acid gas passes off through an opening in the top of the iron tank.

To produce fusion the caustic soda is heated to 400 deg. to 500 deg. Peroxide of manganese and magnesium oxide are added, and magnesium carbonate forms and decomposes so that only a small amount of the oxide is necessary. Jacques states that he used 100 cells each 12 ins. deep and 12 ins. in diameter, and obtained a current of 18 amps. at 30 volts for 18¾ hours with a consumption of 8 lbs. of carbon. In another experiment he reports that with 100 cells he obtained 90 volts and 16 amps., giving him an efficiency of 85 per cent of the energy of the carbon consumed.

C. J. Reed says the process is electrothermic and not electrolytic. He finds that illuminating gas will also produce the same effect as air. He also finds that the carbon may be replaced by a metal and that the polarity changes at a red heat.

Prof. Rogers adds that without having carried these experiments to the same extent as reported by Jacques, he, nevertheless, has been able to get only a maximum of about .3 volt e.m.f. with an iron containing vesel and electrode, and he questions Jacques' results, even though they are reported to be supported by the authority of Profs. Cross and Rowland. Employing a platinum crucible instead of one of iron as the containing vessel and electrode, Prof. Rogers found an e.m.f. of nearly .5 volt at a red heat of the caustic soda.

According to a United States patent issued to Blumenberg nearly a year ago, superheated steam is injected into the fused electrolyte consisting of lime, caustic soda and cryolite. He claims these oxides to give up a part of their oxygen to the carbon electrode, forming carbon monoxide and dioxide, and then receive back their oxygen from the steam, setting free hydrogen. If this is the end of the process, it would hardly seem probable that heat or electrical energy would be liberated.

Prof. Rogers concludes that while the problem of obtaining electricity from carbon direct has not yet received a practical solution, it can not yet be regarded as insoluble. The chance of success, however, would seem much better in endeavoring to oxidize the easily obtained hydro-carbons and carbon monoxide.

If we keep closely to the theory of the galvanic cell as worked out by Nernst and others, we cannot get far astray and are likely to reach valuable results in the solution of this greatest of technical problems.

If any approach to 100 per cent of the energy of the coal can be secured an industrial revolution would follow, in comparison with which the invention and perfection of the steam engine is almost insignificant.

## DROP IN ALTERNATING CURRENT CIRCUITS.

At the recent meeting of the Northwestern Electrical Association, Mr. Geo. L. Thayer read a paper on "The Design of Secondary Circuits in Alternating Plants," which was without question the most important contribution of the meeting from the standpoint of the central station man. Owing to lack of space the paper unfortunately cannot be reprinted in our columns, but we make an abstract of that portion which dealt with drop in alternating current lines.

TABLE II.—125 CYCLES.
100 volts. Distance, 500 feet. Direct current drop, 2 per cent.

| Wire. | Amperes. | Power Factor 100 Per Cent. | | | Power Factor 95 Per Cent. | | |
|---|---|---|---|---|---|---|---|
| | | 12" | 24" | 36" | 12" | 24" | 36" |
| 0000 | 40.8 | 2.382 | 2.458 | 2.527 | 4.71 | 5.24 | 5.70 |
| 000 | 32.4 | 2.327 | 2.296 | 2.350 | 2.11 | 4.51 | 4.70 |
| 00 | 25.6 | 2.146 | 2.198 | 2.225 | 3.70 | 4.00 | 4.18 |
| 0 | 20.4 | 2.085 | 2.139 | 2.150 | 3.34 | 3.60 | 3.74 |
| 1 | 16.2 | 2.064 | 2.085 | 2.108 | 3.06 | 3.25 | 3.35 |
| 2 | 12.8 | 2.044 | 2.055 | 2.065 | 2.83 | 2.196 | 3.60 |
| 3 | 10.2 | 2.025 | 2.036 | 2.042 | 2.64 | 2 75 | 2.80 |
| 4 | 8.1 | 2.019 | 2.024 | 2.027 | 2.49 | 2.55 | 2.62 |
| 6 | 6.4 | 2.011 | 2.016 | 2.018 | 2.38 | 2.45 | 2.49 |
| 8 | 5.1 | 2.009 | 2.011 | 2.012 | 2.30 | 2.35 | 2.39 |

The accompanying tables enable a comparison to be made between the effects on drop of the frequency, distance apart of line wires, and the size of conductors. It should, however, be borne in mind that the increased drop with large conductors is not due to the size of the conductor, but to the large current carried. In fact, for the same current the inductive drop becomes smaller as the diameter of the conductor is increased.

Both tables are based on a 2 per cent drop with direct current over a line 500 ft. long, the voltage being 100. Table I. is for a frequency of 60 cycles, and Table II. for a frequency of 125 cycles. The first division in each table refers to alternating current in a non-inductive (incandescent lamp) circuit, and the second division to an inductive circuit having a power factor of 95 per cent.

A study of the tables affords some interesting information. As long as lamps form the only load—that is, when the power factor is 100—the line losses do not differ appreciably from what they would be with direct currents. If, however, a portion of the load is in small motors or in arc lamps, the inductive drop in the lines begins to assume importance. With a power factor of 95 per cent, the drop in a No. 4-0 wire is increased 50 per cent at 60 cycles and 100 per cent at 125 cycles, the lines being 12 ins. apart. It is also evident that the lower the power factor the poorer the regulation of the secondaries. The inductive effects can be kept down by subdividing the heavy circuits, bringing the wires closer together, using lower frequencies and by operating motors with good power factors. Although the inductive effects decrease quite rapidly when the conductors are brought within 12 ins., it is hardly practicable to make the distance less than this on overhead work. On the underground work at St. Louis, where the wires are very close together, the effects of inductance are very small. Beyond 36 ins., the limits of the tables, the increase in inductive effect is not very great, with increased distance apart.

It will be noticed how rapidly the inductive drop decreases with the size of wire. For example, in a 4-0 circuit at 125 cycles, and with wires separated 36 ins., the direct-current drop is 2 volts; the drop with a load having a power factor of 100 per cent is 2.527 volts; and the drop with a load having a power factor of 95 per cent is 5.70 volts. With a No. 8 wire the same drops are 2, 2.012 and 2.39 volts respectively. With lower power factors the drop becomes correspondingly greater, and as some arc lamps and motors have a power factor below 70 per cent, they may be extremely large.

TABLE I.—60 CYCLES.
100 volts. Distance, 500 feet. Direct current drop, 2 per cent.

| Wire. | Amperes. | Power Factor 100 Per Cent. | | | Power Factor 95 Per Cent. | | |
|---|---|---|---|---|---|---|---|
| | | 12" | 24" | 36" | 12" | 24" | 36" |
| 0000 | 40.8 | 2.077 | 2.107 | 2.120 | 3.18 | 3.40 | 3.54 |
| 000 | 32.4 | 2.051 | 2.069 | 2.078 | 2.90 | 3.11 | 3.20 |
| 00 | 25.6 | 2.037 | 2.044 | 2.052 | 2.70 | 2.87 | 2.94 |
| 0 | 20.4 | 2.023 | 2.029 | 2.034 | 2.56 | 2.68 | 2.75 |
| 1 | 16.2 | 2.015 | 2.019 | 2.022 | 2.44 | 2.54 | 2.58 |
| 2 | 12.8 | 2.010 | 2.013 | 2.015 | 2.35 | 2.41 | 2.44 |
| 3 | 10.2 | 2.006 | 2.008 | 2.010 | 2.25 | 2.31 | 2.35 |
| 4 | 8.1 | 2.005 | 2.006 | 2.006 | 2.19 | 2.23 | 2.25 |
| 6 | 6.4 | 2.003 | 2.004 | 2.004 | 2.12 | 2.16 | 2.18 |
| 8 | 5.1 | 2.002 | 2.003 | 2.003 | 2.10 | 2.13 | 2.15 |

## Electricity in a Medical Clinic.

In the description of the generating plant of the Polhemus Memorial Clinic which appeared in the February issue, it is stated that the Ball & Wood engines have cylinders 13 ins. x 12 ins., a horsepower of 90 at 275 r.p.m., and that they are equipped with Rite's governor. The engines in question are three Ball & Wood simple engines, with cylinders 13½ ins. x 11 ins., and proportioned to give 80 h.p at 275 r.p.m. at 80 lbs., with 5 lbs. back pressure. The engines are equipped with the Ball & Wood standard governor, and not with the governor mentioned in the article. The medical apparatus described in the article was designed and furnished by Louis M. Pignolet.

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## METER TESTING AND HANDLING.

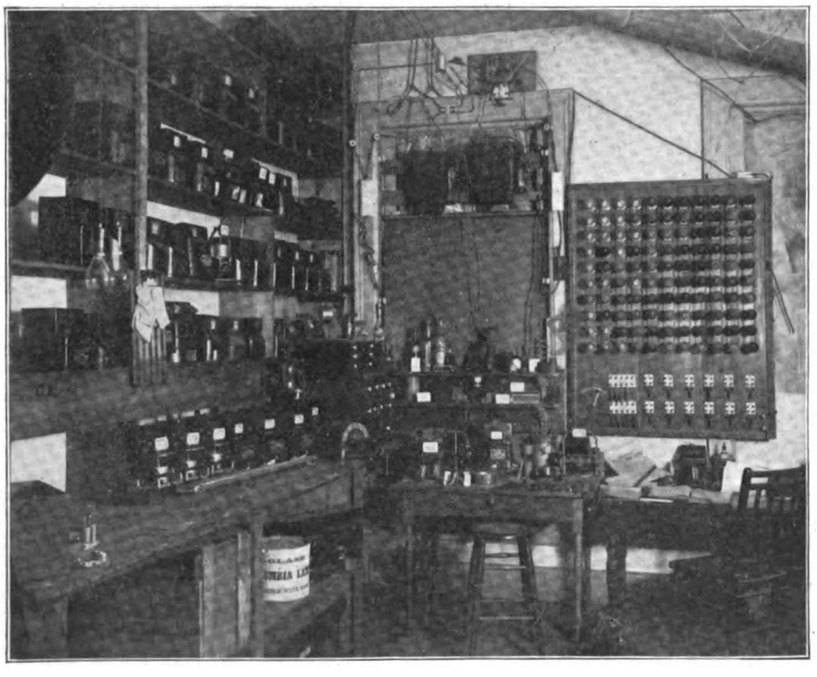
BY JAMES E. JUDD.

A meter testing department has come to be one of the prime requisites for a modern central station, and hardly any station can be called thoroughly up-to-date which does not make provisions to insure the satisfactory operation of the meters used, from the standpoint of the customer, as well as of the station.

One of the greatest defects in the present meter system is the inability of the meters on the market to remain absolutely constant; and it is the exception, rather than the rule, that a meter which is accurate when installed, will be accurate after a year's service. For this reason it is highly important that each instrument should be thoroughly tested and calibrated, not only when it comes from the factory, but also at definite intervals during use.

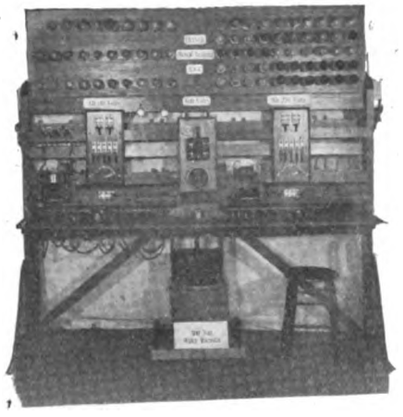
There are few central station managers who will not readily see the advisability of such tests, but there are many who are slow to introduce a meter testing department, owing to the immediate expense involved.

A testing department when properly planned and operated can take care of a large number of meters with comparatively small cost, and with a decided gain to the station. It is the purpose to call attention here to the meter testing department which has been developed after considerable study and use, and operated in connection with a station supplying light and power in a city having a population of 18,000. The equipment here described, however, is amply large for stations supplying ten times that number of inhabitants.

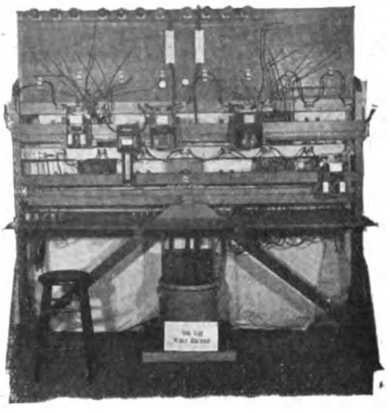


TESTING RACK.

Meter testing is a very delicate operation, and should be done with the greatest care. The best measuring instruments should be employed, which should be calibrated from time to time to insure their accuracy. The testing laboratory should be far removed from all jar or vibrations which would tend to interfere with the calibration of the meter. The utmost cleanliness must be observed, and dust covers should be provided for standard meter and other measuring apparatus. The rack on which the meters are placed during the test should be substantial, and very carefully constructed. The one here shown in photograph was built of good grained oak, 7 ft. 8 ins. long, by 7 ft. 6 ins. high, and of skeleton form. One side is used for testing ampere-hour meters, and is arranged so that sixteen meters can be tested at one time, if necessary. It is provided with flexible cords and plugs, so that one meter may be removed at any time without disturbing the others. A standard ampere-hour meter, which has been carefully calibrated, is mounted permanently at the head of the board, and is provided with a special cover with movable mica windows, so that fans, dial and tell-tale hands may be seen at any time. The dial window may be opened at will, thus facilitating the resetting of hands before starting the test. The instruments used on this side of the rack consist of one low reading and one high reading ammeter, the smaller reading from 0 to 2 amps., and the higher from 0 to 25 amps. Either instrument may be thrown in or out of circuit without opening the circuit of the meters under test, also by the use of a third switch, both instruments may be cut out without interfering with the test, the instruments being only cut in from time to time



WATTMETER SIDE OF RACK.



AMPERE-HOUR SIDE OF RACK.

to see that the load has not changed. A shunt is placed around the low reading instrument, and is always left closed, except when the instrument is in use, so that should a heavy load be accidentally thrown on, no damage will result.

The other side of the rack is used to test wattmeters, and is divided into three sections, one each for 108 and 220 alternating, and the third for 500 volts direct. As may be seen in Fig. 1, a lamp bank is used for load on the 108-volt and 220-volt sections, and a water rheostat for the 500-volt. The meters on this side are held in position by clamps, and have a leveling piece beneath, which may be raised or lowered with a thumb-screw, while the meter may be given an in or out motion with clamp screws, which are shown on side in Fig. 1. The leads or meters are of flexible cable with special terminals, which are arranged to sink to the level of the board when not in use. The lamp banks on this side of the board are so arranged that any load from ten lamps in series to forty lamps in multiple, may be thrown on the meter, without making it necesary for the operator to leave his chair.

Each of the alternating current sections is provided with two portable, direct reading watt-meters, one for light loads, and the other for heavy loads. The instruments used in connection with the 500-volt section consist of two ammeters, one reading from 0 to 10 amps., and the other from 0 to 100 amps.; also a 650-volt voltmeter.

The water rheostat used for the 500-volt section is somewhat different from that ordinarily used, in that both its terminals are fixed for various loads; that is, the positive side consists of several elements, each connected by different wires to various switches on the board, so that by properly manipulating the switches, almost any load

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required may be obtained. This rheostat requires occasional addition of water and salt, or other substance used to make the water conduct to replace that lost by decomposition or evaporation, which would cause the resistance of the solution to vary. As will be seen in Fig. 2, a smaller water rheostat is placed under the center of the board, consisting of a 20-gal. jar, in which two movable iron plates are fitted in a frame work built in the jar; these being adjusted from the operator's seat at the board by cords passing up over a pulley, which is direct connected to a wheel on the front of the board.

The smaller water rheostat is used only to adjust any difference in load caused by poor regulation, or otherwise, after having approximately adjusted the load required. The board being built of skeleton form, can be readily adjusted to hold any make of meter on the market, there being several different kinds shown connected in circuit in Figs. 1 and 2, viz: Shallenberger, Scheeffer, T. H., Fort Wayne, and a Hale discount meter.

# The Induction Motor.

## HOW ENERGY IS TRANSFERRED FROM THE PRIMARY TO THE SECONDARY IN INDUCTION MOTORS.

BY WM. BAXTER, JR.

There are many men, well informed in relation to the actions of continuous current machinery, who cannot fathom the mysteries of alternating currents. This condition of things is due, in part, to the fact that the latter subject is more difficult to understand, and in part to the prevailing notion that the difficulties are more formidable than they really are. The latter impression has been created, to a very great extent, by the abstruse manner in which alternating current problems are generally treated. There are certain points in connection with the action of continuous currents that were regarded as very complicated only a few years ago, as, for example, the theory of compound winding for constant potential generators, which formed the basis for numerous lengthy and more or less complicated mathematical demonstrations; but at the present time this subject has become so well understood that simple explanations are found sufficient to elucidate the principles involved.

It is not probable that alternating current actions will ever be interpreted with the same degree of simplicity as the continuous, since, in many cases, they are more complicated; but many of the present difficulties will eventually be brushed aside. In fact, even now it is not unusual to read occasionally a simple explanation of some action previously regarded as only capable of being demonstrated by the aid of the higher mathematics.

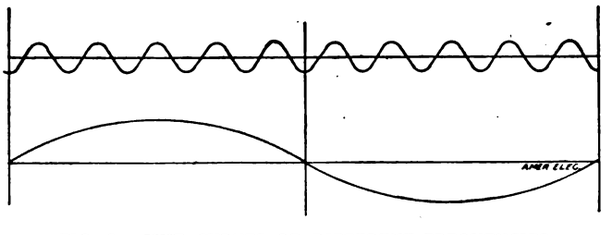


FIG. 1.—SINE CURVES OF DIFFERENT FREQUENCIES.

The theory of the polyphase induction motor is generally regarded with profound respect, but in this article an effort will be made to show that it is, after all, quite simple. When a man concludes to familiarize himself with the operation of induction motors, he starts by reading some elementary explanation of the subject. From this he learns that the effect of magnetizing the field by means of two or more alternating currents of the same frequency, but out of phase with each other, is to produce a magnetic flux that rotates at a velocity proportional to the frequency of the currents, and that if the phase displacement is properly adjusted to the number of currents, and the currents are equal, the flux will rotate at a uniform rate, and the strength of the field will be constant. From this he can see at once that if an armature is placed within this rotating field it will be dragged around, since the conductors on the armature will be cut by the lines of force of the flux, and the e.m.f. so induced will set up currents that will endeavor to set themselves at right angles to the magnetic field. But as the field rotates, the currents induced in the armature conductors must also rotate to preserve the right angular position, and as the conductors are fixed in the armature they cannot rotate without carrying the latter with them.

Thus the explanation makes the cause of the rotation of the armature quite clear, but it does not throw any light upon the manner in which the energy of the primary currents is transferred to the rotating secondary, and since the latter cannot develop a torque without such a transfer, it is obvious that a compensating inductive action must be set up in the primary or field coils. The seeker for knowledge begins to study the subject with a view to clearing up this mystery, and naturally concludes that the armature currents in some way set up e.m.fs. in the field coils that are the equivalents of the energy appearing in the armature.

The description of the action of the motor tells him that the armature currents alternate with a frequency much lower than that of the primary currents, and when he begins to contemplate this statement he finds himself completely bewildered, for at once an effort is made to reason out the nature of the inductive action that a current of low frequency can have upon one of much higher frequency. A picture of two such currents is drawn in the mind something like that shown in Fig. 1, and then the effect of the lower current upon the upper one is studied. The more the picture is studied the deeper the mystery grows, because all that can be made out of it is that while the lower current is diminishing it will put an induction in the upper current in one direction, and while it is increasing it will put an induction in the upper current in the opposite direction; but as one wave of the lower current laps over several waves of the upper one, each one of its inductive actions will be against one set of the impulses of the upper current, say the positive, and in the same direction as the other set. The other half of the lower wave will effect the upper current in just the opposite order, hence the two effects will neutralize each other, and only result in producing a distortion of the upper current.

All this confusion, which is due to an improper interpretation of the action, can be cleared away by a simple statement of the fact that the armature current, as a whole, when considered with reference to its position relative to the rotating field, does not alternate, but is continuous and of constant strength so long as the primary currents remain constant.

That this statement is true can be made evident by the aid of Fig. 2, which represents a type of armature winding commonly used in induction motors. This winding consists of two end discs, connected by means of the rods marked a, b, n, m, etc.

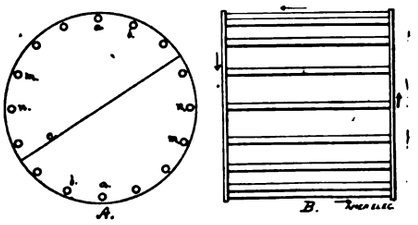


FIG. 2.—TYPE OF INDUCTION ARMATURE WINDING.

Suppose an armature provided with such a winding is placed in a magnetic field and is caused to revolve; then it is evident that when the rods a, a, are passing the center of the magnetic flux, they will have induced in them an e.m.f. that will be higher than that induced in any of the other rods. At this same instant the e.m.f. induced in the rods n, n, will be zero, as these will be moving parallel with the lines of force. As each pair of rods comes successively into the position of rods a, a, it will be the seat of the highest e.m.f. The action, as can be seen, is that which is explained in any elementary book upon dynamo-electric machinery; and as we know

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the currents induced in any individual pair of rods, as a, a, b, b, etc., will alternate with a frequency equal to the velocity of rotation of the armature, but the currents flowing in all the pairs of rods, taken with reference to their position in space, will be continuous. That is, in all the rods above n, n, the currents will flow in the same direction; and in those below they will flow in the opposite direction, and this order will not be disturbed, no matter what the velocity of the armature may be.

Since, in this illustration, the field is stationary, it follows that as the armature currents are always in the same direction with reference to a fixed point in space, they are in the same direction with reference to the magnetic flux, for this is also taken as fixed in space. If the field rotates, the continuous current in the armature will also rotate and at the same velocity as the field. That is, the points n, n, at which the induction is zero, will always be on a line at right angles to the direction of the flux; and the points a, a, at which the induction is maximum, will always be on a line parallel and coincident with the center line of the flux. If the field remains stationary and the armature revolves, the only effect of changes in velocity will be that the e.m.f. will vary, increasing and decreasing with the speed.

If the armature remains stationary and the field flux revolves the result will be the same; that is, the e.m.f. induced in the conductors will increase and decrease with the velocity with which the field rotates. In a continuous current motor the field remains stationary and the armature revolves, and in the multiphase motor the field, as well as the armature, rotates. If both parts rotate at the same velocity the effect upon the armature conductors is the same as if both stood still, for in this case the latter are not cut by the lines of force. A continuous current motor at a standstill does no work, hence an induction motor, when running at synchronins, can do no work. When the armature of an induction motor runs at a lower velocity than the rotating field the effect upon the conductors is the same as if the armature stood still and the field rotated with a velocity equal to the difference between the field and armature; that is, with a velocity equal to the slip.

From the foregoing it can be seen that whatever the velocity of the armature of an induction motor may be the inductive action therein is precisely the same as that in the armature of a simple continuous-current motor, and the only difference between the two machines is in the manner in which the inductive action which compensates for the energy of the motor is impressed upon the main currents. In the continuous current motor the main current passes through the armature, and the c. e.m.f. induced therein is the representative, so to speak, of the work done. But in the induction motor the main current does not pass through the armature, and therefore the e.m.f. induced therein does not account for the work done. The current induced by this e.m.f., however, sets up a magnetization which reacts upon the field coils, and thus sets up therein an induction that accounts for the work done.

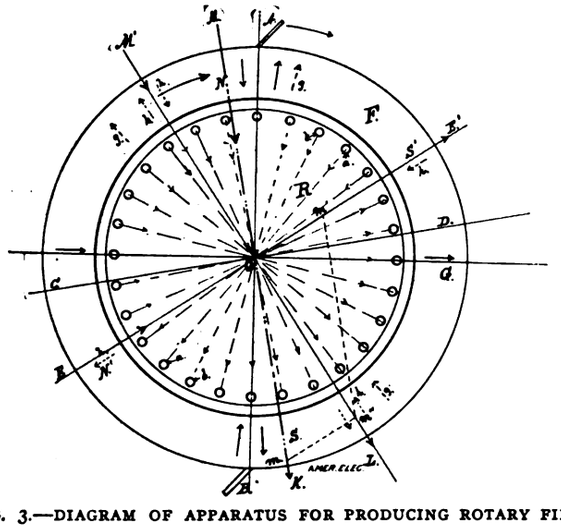



FIG. 3.—DIAGRAM OF APPARATUS FOR PRODUCING ROTARY FIELD.

This part of the action can be made clear by means of Fig. 3, which represents an apparatus by means of which a rotating magnetic field can be obtained with a continuous current, thus simplifying the subject by removing the complication arising from an effort to conceive of the manner in which the currents of a polyphase system produce the rotating magnetization. The ring F is supposed to be wound like a Gramme armature, and to be provided with a commutator face on the periphery, after the fashion of a Siemens & Halske generator.

With such a device it is evident that if the continuous current is admitted through the brushes A, B, and flows through the wire in the direction indicated by the solid arrows, that N and S poles will be developed at top and bottom, as shown, and lines of force will traverse the inner space from N to S. If the brushes A, B, are rotated, the points at which the current enters and leaves the wire will rotate; therefore the poles N and S will rotate, and so will the lines of force within the ring; that is, we will by this process obtain a rotating field within the ring F. If the magnetic polarity of the iron could change instantly the poles would always remain upon the diametrical line joining the brushes, no matter what the velocity of rotation might be; but as it requires a certain amount of time for the polarity of the iron to change, the poles will lag behind the line upon which the brushes rest and be on some other line, as M K. The angle M O K, formed by the line through the poles and the line through the brushes, will increase as the velocity of rotation of the brushes is increased.

As the brushes rotate the lines of force within F must necessarily cut through the wires upon the inner side of the ring, and thus induce e.m.fs. therein. If the poles N S did not lag behind the brushes, these e.m.fs. would neutralize themselves, for one-half would be in one direction and the other half in the opposite direction; but in consequence of the lag of the poles this neutralizing action is not completed, for while the wires in the arc A D are the seat of an induction in one direction, those in the arc D B are the seat of an opposite induction, and the two arcs are of unequal lengths. Hence, the net inductive action upon the wire wound upon F is the difference between these two opposing actions. This inductive action appears in the circuits wound around F, as a counter e.m.f., and represents the energy absorbed in eddy currents and hysteresis.

We will now consider the effect of the rotating field upon the wires wound upon the drum, R, which represents an armature arranged to revolve within F. As we have already explained in connection with Fig. 2, if R revolved at the same velocity as the field—that is, at the same velocity as the brushes A B—there would be no inductive action. But if R revolves at a lower velocity there will be an inductive action. If R stands still, the inductive action will be the same as if it ran at a lower velocity than the rotating field, the only difference being that the e.m.f. will be greater. This being the case, we will regard R as stationary, as by so doing the action can be made clearer. Let the wires upon R be connected with each other at both ends, as shown by the broken lines, so as to form independent closed loops.

If we consider the instant when the brushes are in the position shown in the figure, it will be evident that the rotating flux, whose center line is M, K, will cut the armature wires and induce therein e.m.fs. in the direction indicated by the arrow heads upon the broken lines; the induction in all the wires above the line C D being in one direction, and in those below it in the opposite direction. In consequence of these e.m.fs., currents will flow in all the loops, and these will develop an armature magnetization in the direction of the line C D. But, as was shown in connection with Fig. 2, this magnetization will rotate with the field flux, always retaining the same relative position; therefore it will cut the conductors upon R, and thus induce e.m.fs. therein. These e.m.fs. will be zero, or nearly so, in the wires near the line M K, but will have the maximum value in the wires near the line C D. The

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e.m.fs. induced by the field flux will be nearly zero in the wires near the line C D. Now the e.m.fs. induced by the armature magnetization will be in the same direction as those induced by the field flux in the wires below the line C D, on the right side of R, and in the wires above this line on the left side of R, but they will be in opposite directions in the wires above the line on the right and in those below the line on the left. The effect of this will be that in some of the loops near the line C D the e.m.fs. induced by the field flux will be overpowered by the e.m.fs. induced by the armature flux, and as a consequence the currents will be reversed. On this account the line that divides the positive from the negative inductions upon the armature will be shifted back of C D to a position E $E^1$.

The faster the brushes A B revolve the higher the e.m.fs. induced in the wires upon R, therefore the stronger the currents developed, and the stronger the armature magnetization. The stronger the armature magnetization the higher the e.m.fs. induced in the armature wires by it, and the greater the angle through which the line E $E^1$ will be shifted. From this we see that the greater the velocity of the brushes, or, what is the same thing, of the rotating field, the greater the lag of the field magnetization M K, and the greater the lag of the armature magnetization E $E^1$.

The armature flux along the line E $E^1$ not only cuts through the wire wound upon the armature, but also through the wires upon the inner surface of ring F. The rotating field flux M K, as we have seen, has but a small effect upon the field wires, and would have none at all if the line M K did not lag behind the brushes. The armature magnetization along the line E $E^1$ lags much more than the field flux, and its effect upon the field wires is correspondingly increased. As can be plainly seen, the armature as well as the field ring F, wires, are now subjected to the action of two magnetizations, one along the line M K, and the other along the line E $E^1$. We can consider the action of each one of these separately, or we can regard them as the components of the resultant magnetization along the line $M^1$ $L^1$, either method will lead to the same result.

Considering the action of the resultant, $M^1$ L, the first thing we notice is that it lags behind the brushes by a greater angle than M K, hence it will set up a greater counter e.m.f. in the field coil than the latter. The inductive action of $M^1$ L in ring F will be in one direction above the line E $E^1$, and in the opposite direction below this line. The coils constituting the circuits between the brushes A B are not equally divided by this line, the arc A $E^1$ being much shorter than the arc $E^1$ B. The e.m.fs. induced by the magnetization $M^1$ L will be in the direction of the arrows g, and this, as can be seen, is in opposition to the current from A to E, and with the current from A to $E^1$. The difference between these two arcs, which is equal to twice the arc $M^1$ A, represents the preponderance of the counter over the direct e.m.f. induced in F by the rotating flux $M^1$ L.

This c. e.m.f. induced in the primary compensates for the energy transferred to the armature, B, and actual measurements would show that this e.m.f., multiplied by the current in F, would be equal to the energy appearing in the armature in every form.

If we investigate the action of each flux separately, that is, of the rotating field flux M K and the armature flux E $E^1$ we will find that the action of the latter upon the wire on the field ring F will be such as to develop a counter e.m.f. from A to L, and a direct e.m.f. from A to $M^1$. The arc in which a c. e.m.f. is impressed is greater in this case than when the resultant $M^1$ L is considered, but to offset this the magnetization E $E^1$ is smaller, as can be seen by comparing the lengths of the lines Om' and Om''. If the diagram were accurately drawn, it would be found that the product of Om' by the arc A L, minus the arc A $M^1$, would be just equal to the product of Om'' by the difference between the arcs A E and A $E^1$.

As Fig. 3 is a simple continuous current device, it is not difficult to trace out the inductive actions of the magnetizations M K, and E $E^1$, and we can readily see that the c. e.m.f. induced in F by E $E^1$ is proportional to the energy transferred to R, and in fact is an accurate measure of it. The flux M K has little effect upon F, simply because the points where the current enters and leaves the wire rotate, and always are in the same position relative to this flux. If F were magnetized by the two alternating currents of a two-phase system, the result would be different as regards the flux M K, but the same as regards the flux E $E^1$. If alternating currents passed through the wire on F the coils in the quadrant to the left of brush A and those in the quadrant to the right of B would be traversed by one of the currents, and the remaining coils would be traversed by the other current.

With this arrangement the points where the currents would enter and leave would be fixed, and as a result the inductive action of the flux M K would not be neutralized. Under these conditions if R were rotated at the same velocity as the flux—that is, in synchronism with it—no induction would be set up in its wires, as these would not be cut by the lines of force; therefore, the only flux that would cut the wires on the inner side of F would be M K. This induction would be alternating, and owing to the angular relation of M K with reference to the field coils and the phase of the currents flowing therein, it would act nearly in opposition to the e.m.f. of the current, the impressed e.m.f, and result in causing the current to lag very much behind its e.m.f., and therefore to have but a small energy value. The action of the flux M K upon the field coils would be the same as that which takes place in a choking coil, the energy in the circuits would be cut down, but none of it would be transferred or abstracted from the circuits in any way.

If R is allowed to run at a slower velocity than the rotating field M K, then currents will be developed in its coils, and the flux E $E^1$ will appear, and this cutting through the inner sides of the field coils will induce therein c. e.m.fs. which would have the effect of reducing the lag of the current and increasing the energy thereof. The increase of energy in the field circuits would be directly proportional to the e.m.f. induced therein by the flux E $E^1$, and as in the case of the field developed by the continuous current and the rotating brushes, this e.m.f. would be a true measure of the energy transferred from the field coils to the armature. The flux M K, therefore, simply acts as a regulator of the amount of energy appearing in the field coils, while the flux E $E^1$ represents the transfer of energy from field to armature, and is a measure of the total work done; that is, the e.m.f. induced by E $E^1$ in the field coils multiplied by the current in phase with it is equal to the energy abstracted from these coils, which appears in the armature as electrical, mechanical and thermal energy.

## NOTES.

**Worcester Polytechnic Alumni Dinner.**—The annual dinner of the Worcester Polytechnic Alumni Association of New York took place in New York on Feb. 3. In an address President Mendenhall called attention to the great growth of the institute from a single building, besides the shops, and thirty students, to a teaching force of forty and an equipment which has involved an expenditure of $112,000 on apparatus alone during the past ten years.

**New England Electric Railways.**—A recent map published by Mr. R. H. D. Derrah, of the Boston Elevated Railway Company, plots 2157 miles of electric railways in the States of Massachusetts, Rhode Island and Connecticut. The map has a special interest from showing the network of systems developed in these States, which in time will be duplicated everywhere in the United States where there are thickly populated districts. One can now make an uninterrupted journey in New England on electric railways between towns in New Hampshire and in southern Massachusetts, Connecticut and Rhode Island.

**Y. M. C. A. Electrical Club.**—The Young Men's Christian Association of Chicago has a flourishing electrical club, which holds stated meetings for the discussion of electrical questions. Among topics recently announced is "Do electrical occupations pay," and to obtain data for its discussion. Mr. George A. Damon, director of the club, has addressed a letter to a large number of men of acknowledged reputation who have attained success in various electrical lines, submitting a comprehensive list of questions for answer. In other large cities it would appear desirable for the Y. M. C. A. to extend its usefulness by the addition of a similar branch.

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**Two Electrical Journals Combined.**—Beginning with the issue of March 11, the two weekly electrical journals now published under the names of "The Electrical World" and the "Electrical Engineer" will be issued as one publication, under the name of the "Electrical World and Electrical Engineer." The issue of March 4—the last under its present name—of the first-mentioned journal commemorated its quarter-century of existence, having been founded as the "Operator" in 1874, and transformed into "The Electrical World" in 1883. The "Electrical Engineer" was founded in 1882 as a monthly, becoming a weekly in 1889.

**Electric Platform Railway at Paris Exposition.**—Our Paris correspondent writes that after a six months' experimental trial, just finished of a 1000-ft. section, the administration of the Paris Exposition of 1900 has given a contract for a movable platform for passenger traffic between the Esplanade des Invalides and Champs de Mars. The platform will consist of two parts, one having a speed of 2.4 miles per hour, and the other a speed double this. Power will be furnished by three-phase motors, of which 28 were used in the successful trial mentioned, four in series on a 212-volt circuit, the frequency being 25. The platforms will carry a central rail, articulated at intervals of 13 ft. This rail will bear on pulleys which will be geared to three-phase motors, the shaft carrying a large and a small pulley to give the proper relative speeds to the two platforms.

**National Association of Municipal Electricians.**—A meeting of the executive committee of the Fire and Police Telegraph Superintendents' Association was held at Boston on Jan. 28, at which the name of the body was changed to the National Association of Municipal Electricians, and the annual meeting fixed for Sept. 5, at Wilmington, Del. In connection with this meeting there will be held an exhibition of electrical and mechanical apparatus used in various departments of electrical work. Among the papers already promised are the following: "The Laws and Government of the Wire Department of Boston," by Commissioner Thomas W. Flood; "Licensing of Employees Engaged in Electrical Work and the Improvement of the Quality of Work and Material," by Capt. William Brophy, of Boston; "Advisability of Concentrating the Control of all Municipal Electrical Interests Under One Head," by Morris W. Meed, of Pittsburgh; "The Underground System as Applied to the Fire Alarm Telegraph," by S. L. Wheeler, city electrician, Springfield, Mass; "The Police Signal System of Boston," by John Weigal, superintendent police telegraph, Boston; "Aerial Construction of Fire and Police Telegraph Lines," by W. H. Thompson, city electrician, Richmond, Va.; "Progress and Development of the Municipal Electrical Interests of Canada," by G. F. MacDonald, Ottawa, Canada.

**Elevated Railway Electric Traction.**—The president of the South Side Elevated Railway Company of Chicago, in his annual report, speaks in the highest terms concerning the favorable experience during the past years with electric traction on his road, the Sprague multiple-unit system being used. Owing to the reduction of operating expenses incident to the use of electricity and the increased traffic attracted by the improvement in service entailed, the net earnings were double what they had been during the same period of time just previous to electric operation. The reliability of the Sprague system, he states, had been fully tested this winter, when 150 cars (the entire rolling stock) were in daily operation, Sundays excepted, for many weeks. The storage battery auxiliary is also highly praised, the battery reducing the fluctuations, enabling the generating plant to be worked more economically, and obviating the necessity which would otherwise have existed for putting in more machinery. The cost per annual maximum h.p., it is stated, did not exceed $15, general expenses, insurance, depreciation, interest and taxes being included. Taking the months of November and December, 1897 and 1898, for comparison, steam being used during the first period and electricity during the second, we have the following remarkably favorable showing for electric traction:

| November— | (a) | (b) | (c) |
|---|---|---|---|
| 1897, steam ..... | 87.3 | 77.7 | $10,603.80 |
| 1898, electric ..... | 57.3 | 47.7 | 39,448.56 |
| December— | | | |
| 1897, steam ..... | 83.6 | 73.8 | 14,691.69 |
| 1897, electric ..... | 55.0 | 45.4 | 45,355.68 |

Here (a) is the ratio of expenses to earnings, including "Loop" rental, taxes and licenses; (b), ratio of expenses to earnings, excluding "Loop" rental, but including taxes and licenses; (c), net earnings. The road included in "Loop" operation consists of 19.44 miles of track.

**The Electrical Exhibition.**—One of the features of the electrical exhibition to be held May 8 to June 3 at Madison Square Garden, New York, in connection with the twenty-second convention of the National Electric Light Association, is an exhibit of automobiles, which will be the most complete thus far held in the country, the space set aside for this purpose having already been oversubscribed for. Another new feature is a special section for models of new inventions, which will give inventors an ideal opportunity and at nominal cost, to bring their patents before those most likely to be interested. The exhibits of boilers, engines and steam specialties, which at former shows were located in the basement, will be placed on the main floor, and the space allotted for these classes is almost entirely disposed of at this early date. Arrangements are being made for the meeting in the garden of engineering societies during the time of the exhibition, and special days are being appointed for the attendance of various classes, one having been fixed for exporters in and around New York City. Judging from present indications, late comers applying for space will have to be turned away; the contracts already closed are far in excess of previous years, and space in the garden, large as it is, promises soon to be filled to overflowing.

**Municipal Ownership.**—The Jackson, Mich., "Sunday Herald" says that if Jackson's water system is to be taken as an illustration of the "superior benefits" conferred by municipal ownership, it is not likely that the citizens will exhibit eagerness or undue haste to acquire electric lighting or railway plants. Detroit, it says, furnishes as much water for $5 as Jackson does for $16, and proposes to reduce the tax still lower. Jackson compels its water patrons to pay the entire cost of water for fire and other public purposes, and then takes $16,000 of their money annually and turns it into the contingent fund to help out the taxpayers who do not patronize the water works. Gas has been reduced since the city engaged in the water furnishing business, from $3 per 1000 ft. to $1, but water still holds inexorably to the old rates.

**Electric Light Consolidation.**—As we go to press announcement is made of the consolidation of all the electric lighting central stations in the counties of Essex, Hudson, Passaic, Bergen, Morris, Union and Middlesex, New Jersey. The capital stock of the new company, which is called the United Electric Company of New Jersey, will be $20,000,000, and all of the plants will be under one management. It is planned to build a central power plant on the bank of the Passaic River, from which current will be transmitted to all lighting centers within a radius of 16 or 18 miles. Within the territory affected are the cities of Newark, Jersey City, Paterson, Elizabeth, Passaic and Hoboken. The consolidation was brought about by Mr. Philip N. Jackson, representing the United Gas Improvement Company of Philadelphia. The plants absorbed will be kept as reserve stations for cases of emergency.

**Ether Waves.**—In an address before the recent annual alumni dinner of Worcester Polytechnic Institute, Prof. Hallock referred to the fact that all modern investigation points to the ether and its waves as the seat of force and power. In the case of the ocean, the surface waves range in size from those of the tide which have crests thousands of miles apart and a rate of two in twenty-four hours, to the little choppy waves, a few feet long and with a period of a few seconds. So in the case of the ether, the waves vary from the long, slow waves of Hertz, having a length of several yards and a measurable time of motion, to those of Roentgen, which have a length of less than one-twenty-thousandth of an inch, and which are so rapid that they will travel seven and one-half times around the earth in a single second. Through this wide range, there are an infinite number of separate and distinct forms of waves, each of which has its peculiar characteristics by which it can be recognized as completely as can a well-known face in a crowd of thousands of persons, and each of which is so tenacious of its individuality that some

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of them, coming to us from the distant fixed stars, and having traveled thousands of years, do not lose their own length of time or vibration and can be so accurately determined as to tell the material from which they came, and its condition at the time when they started on their long journey. The waves are so numerous that those coming from the sun, which are not more than from one-thirty-thousandth to one five-thousandth of an inch long and one-millionth of an inch high, pounding away millions of millions of times per second, expend upon each acre of the earth's surface 10,000-h.p. continually. The source of the energy shown in the thunder storm and the cyclone is sometimes a matter of wonder, but when it is considered that one-third of this 10,000-h.p. per acre is absorbed by the atmosphere, it is seen what a vast amount of energy is waiting in the air to be drawn upon in case of disturbances. It is well known that the particles of an electrified body are in motion; in the case of the Roentgen ray tubes, these moving particles set up a bombardment of the cathode, and this in turn sets up the ether wave known as the Roentgen ray. It is certain that in the upper layers of the atmosphere, the density of the air is so small as to approach the condition in the Crookes tubes. Physicists are beginning to think that it is possible that the ether waves from the sun set up a motion in the rarefied air, and this produces the electrification which is manifest in the lightning and always exists even when not so manifested, as is shown by the fact that a flame standing at a distance of only 6 ft. from the wall of a building will show an electrification of 1300 volts above that of the earth.

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**Snow Storms and Electric Traction.**—After the first snow storm of the winter, the New York daily press published what purported to be an interview with President Vreeland of the Metropolitan Railway Company, in which a statement was made that the electric car service was delayed on account of snow on the tracks preventing electric contact with the rails. This led to a number of inquiries to this office from subscribers who had thought—and correctly—that the underground trolley system did not use the ground. It appears that the reporter had misinterpreted a comparison between cable and electric cars, made to bring out the fact that the former, not depending upon wheel friction, were not affected by snow on the track. After the recent storm, the newspapers fell into another error, and attributed the delay in service on some of the new electric lines to failure of electrical apparatus, whereas it was due to the track cause above mentioned. The New York company was evidently unprepared to keep the rails clear, for in Washington, D. C., Manager Coleman by constant and energetic work kept the tracks clear during the same storm, and the running of cars suffered no interruption. though 12 ins. of snow fell. The same underground trolley system is in use in Washington and New York.

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**Portraits of Coulomb and Ampere.**—An eminent member of the French Academie des Sciences writes us concerning a portrait of Coulomb, that the only one known to exist is a painting in the audience room of the Academie, and the authenticity of this is not established. A search was made in the print department of the Bibliotheque Nationale and among publications likely to contain a portrait of Coulomb, but without success. We are indebted to the same



ANDRE MARIE AMPÈRE.

source for a portrait of Ampère, from which the accompanying engraving was made. There are some yet living who knew Ampère, and we are informed that several of these, to whom the original of the engraving was submitted, pronounced the portrait an excellent likeness. Arrangements have been made for obtaining a photograph of the Coulomb portrait above referred to, and when received an engraving from it will be printed in these columns.

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**Electricity on Board Ship.**—In a paper read before the January meeting of the American Institute of Electrical Engineers by Lieutenant-Commander S. Dana Greene facts and figures were given showing the indisputable economy of electric power for driving auxiliary machinery aboard ship. The recent position reported to have been taken by one of the Naval Bureau chiefs that such applications should not be further extended on our warships at present, because we did not have the trained men to care for the machinery, is pronounced absolutely untenable. If, it is added, it is demonstrated that an electric motor is better adapted to drive a deck winch, for example, than a steam or hydraulic or compressed air motor, then it should be installed, and the necessary men to operate it can and should be obtained. If the course suggested by the naval officer referred to had been followed in our navy for the past fifty years, Lieutenant-Commander Greene truly says that we would still have sailing vessels (the frigates and line-of-battle ships of Nelson's day), and our recent unpleasantness with Spain would have terminated very differently.

Referring to experience in the late war, it was stated that all of our regular war vessels were fitted with electric lighting plants, and many of the larger ships were supplied as well with certain electric auxiliaries, such as ventilating fans and ammunition hoists. Two of the "Brooklyn's" turrets were controlled by steam motors, and two by electric motors, and from both official and unofficial sources all of the electrical apparatus on these ships stood the supreme test of battle admirably, and the officers of the "Brooklyn" are enthusiastic over the performance of the electrically controlled turrets. They report that with respect to ease of manipulation and fineness of control, there is no comparison, but rather a contrast. This is high praise from competent authority, for the officers referred to had actual command of the turrets in battle, and their judgment is not only unprejudiced and impartial—it is final and conclusive.

Tests made on the auxiliary machinery of the U. S. S. "Indianapolis" are discussed, and it is shown that the average weight of steam used by the main engines per hour was 33,620.6 lbs., and by the auxiliaries, 10,146.7 lbs. That is, the auxiliaries consumed nearly 25 per cent of the total coal used. The main engines consumed an average of 20.63 lbs. of steam per i.h.p. per hour, and the auxiliaries an average of 119 lbs. per i.h.p. per hour (the lowest being 55.06 lbs., and the highest 318.68 lbs. per i.h.p. per hour). These results are not exceptional; in fact, they are probably better than the average obtained on most warships or merchant vessels. The new British cruiser "Powerful" (14,000 tons displacement), is reported to have used 8,300 tons of coal from England to Hong Kong, of which 3,400 tons (or over 40 per cent) were required for the auxiliaries. Under the most favorable conditions the auxiliaries of a large ship probably consume at least 20 per cent of the total coal and water used. This is more than twice as great as the consumption in a modern central station, and there is no good reason why as good results should not be obtained afloat as ashore.

A calculation is made for a first-class battleship on the basis of 1000 h.p effective at the motors, and the conclusion arrived at, that it is fair to assume that while the average steam consumption can be reduced to 75 lbs. per hour, this is 100 per cent in excess of that required for an electric drive. Assuming the average daily use of 800 h.p. effective at the auxiliaries at sea, this means a saving of 45 tons of coal per day, or that with a given coal endurance (or "steaming radius") a vessel can carry from 10 to 20 per cent less coal; or, expressed in another way, with the same coal capacity she will have from 10 to 20 per cent greater steaming radius. The average price paid in the navy for coal (including stations in all parts of the world) is probably at least $7 per ton, so that in the case assumed there is a direct saving in running expense of $315 per day for coal alone. The use of the present voltage of 80 in the navy is condemned as entirely unsuited for a large generating plant, and the three-wire system, or a standard 220 to 250 volt two-wire system, is recommended instead.

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### The Single-Phase Induction Motor.

The article in another column on the design of a single-phase induction motor will be found of much interest even by those who would not care to construct the machine described, as it involves an excellent illustration not only of the application of various alternating current principles, but of the principles themselves. Inductance, power factor, slip, hysteresis, as well as the principles of the closed-circuit secondary, here appear in a concrete form that enables the mind easily to grasp their significance. We knew, in fact, of no contribution to the subject which so clearly sets in relief the principles of the inductive motor as the article by Mr. Heldt to which we refer. To those taking up the subject of induction motors, the reading of this article, followed by the reading of the articles in two preceding numbers by Mr. Berg, can be recommended as offering a means of making a full acquaintance with a subject that heretofore has been treated in a manner not easy to follow by those lacking an acquaintance with higher mathematics.

### One Hundred Years of Electricity.

An exhibition is to be held at Como, Italy, from May to November of the present year, to celebrate the discovery a century ago by Volta of the primary cell. There have been few or no discoveries more worthy of being thus marked than that of the great Italian. Up to the day of his great discovery there was no knowledge of current electricity, the only form with which acquaintance had been made being the static; and the only source of electricity was the static machine, which is utterly insignificant as a generator of electrical energy. The voltaic cell furnished the first practical source of electrical energy, and in a form that enabled experiments to be made which culminated in that of Faraday —the base of all our present electrical development. Whether we gage the discovery by what has sprung from it, or by its originality, or by its vastly greater importance over any previous discovery in electrical science, it stands forth as one worthy of centennial celebration even unto the end of time.

### Central Station Associations.

A few years ago it was evident from the discussions at the meetings of the Northwestern Electrical Association that few members were selling current on other than flat rates. In view of the generally small size of the plants represented, it was consequently encouraging to learn at the late meeting that not only were meter rates now considered a necessity, but that attention has been strongly turned toward differential charges. There can be no doubt but that the progress made in this direction has been due to the instruction given at conventions, which illustrates the great value of such associations, particularly when representative of the smaller stations, whose owners have not the aid of the technical staff employed in large plants. Even in the case of the latter the comparison of notes among managers and engineers leads to beneficial results, as has been illustrated in the history of the Association of Edison Illuminating Companies, which body has been an important factor in placing these companies far in the lead of most others of similar rank.

### Conductivity of Lamp Filaments.

It is well known that the conductivity of an incandescent lamp filament increases during the first few hours of the operation of a lamp, and that after this first increase it decreases steadily during the entire life of the lamp. According to an authority on the subject, this initial increase in conductivity is due to the perfection of the carbonization of the filament by the temperature of operation. The process of carbonization converts the cellulose thread, which is a combination of carbon, hydrogen and oxygen, into almost pure carbon, thus making a conductor of the perfectly non-conducting cellulose. The conversion, however, is not complete, and in the finished filament there is still some hydrogen. This process continues in the filament after the lamp has been placed in service, and this completion of the carbonization process is the principal cause of the increase of conductivity during the early hours of a lamp's life. As soon as this is completed there is a decrease in conductivity, due probably to a slight wasting away of the filament, as is made evident by the sooty deposit upon the globe of the lamp.

### Electrolytic Interrupter.

In "Among Our Foreign Contemporaries" will be found a description of a new form of interrupter for induction coils, which forms undoubtedly the most important improvement in connection with such coils that has appeared since the day of Ruhmkorff. The device referred to is remarkable both for its extreme simplicity and the perfection of its action, and appears to definitely and ideally solve the difficult interrupter problem. Heretofore

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a weak point of induction coils has been the interrupter, and such forms that have been devised which have approached being satisfactory have also been both complicated and expensive.

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One of the most valuable points of the new interrupter is that it does not involve a low inductance in the primary to obtain the best results, as in the case of all other interrupters. Indeed, the presence of considerable inductance was found by Dr. Wehnelt to be an advantage, actually causing the break to be more abrupt. This will enable the primary of large coils to be wound to almost any desired resistance, whereas at present such coils, to give the best results, should not have more than a single layer, which necessitates often an unduly large current in order to saturate the core.

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**Two-rate Metering.**

We print on another page an article (misplaced in position through the exigencies of "make-up") in which the writer, Mr. Lyman E. Reed, considers the subject of two-rate metering from the consumers' standpoint. The main argument offered would, if well founded, have considerable weight, but it rests upon the assumption that there is a close similarity between the functions of a central station and that of a retailer of merchandise. While the selling of current may be compared to the selling of any other commodity, and in the eyes of the consumer be considered an identity in fact, there nevertheless exists a wide difference between the two functions.

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A central station is primarily a manufacturer of a commodity, and while it also retails its product, this does not necessarily require that it should not be governed by the same considerations that apply in other manufactures. During a dull season a manufacturer will, in order to keep his plant employed, sell his product at a figure far below the average rate, and at no time permit small orders to interfere with the profitable working of his plant. But aside from analogies, which are notoriously unsafe criteria, a central station should, as far as possible, obtain from every consumer a price for the service rendered based upon the cost of that service. There is nothing unreasonable in this view, and as the supply of current is almost necessarily a monopoly, the central station manager is in a far different position from the retail merchant in asking that each consumer shall pay the actual cost of the current furnished, together with a fair profit, instead of overcharging those who should receive consideration, in order to sell at a loss to the small or short-hour consumer.

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A system of discounts on bills is a very rough way of attempting to do justice to the deserving, for it does not necessarily differentiate the long-hour from the short-hour users. The nearest approach to the ideal system appears to be that devised by Mr. Arthur Wright, in which the user is charged the cost price on the use of the part of plant kept for his particular service, and the cost of producing the current consumed, with a profit added. The only objection that appears tenable against this system is that it does not make allowance for those whose maximum demand occurs at other than the hour of maximum load.

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**Engineering Education.**

The day is not very far distant when the engineer graduate was almost invariably regarded askance by the employer, and, indeed, received but little encouragement from any quarter. He was apt to be characterized in terms little complimentary for the fault of his college education—for at times it assumed the aspect of a fault—not only by those who merely echoed the opinion of the time, but in good faith by others who had, without systematic education attained high rank in the engineering world. Even to-day we occasionally hear of one who says he would not employ a college graduate, but in view of the present consensus of opinion, based upon a generation of experience, that systematic engineering education is necessary to engineering success, such cases, instead of doing ill, are more likely to recall Æsop's fable of the sour grapes.

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There were, of course, reasons, though mostly illogical, for the prejudice which formerly existed against the educated engineer. Many—perhaps most—of the great engineers of the day had risen to eminence without the aid of the education decried, and few stopped to think that great minds will reach the goal, whatever the handicap. The profession was based upon methods due to a long line of men whose habits of thought had little in common with those of the college graduate, and the latter, because these methods did not appeal to him, was often condemned as lacking the engineering instinct. Engineering then rested largely on empirical grounds, and the successful exercise of the profession required even a greater exercise of the judgment than at the present day, when this branch of knowledge is thoroughly systematized and its data no longer the dicta of authority but consisting of scientific fact. The lack of the seasoned judgment necessary under the then condition was probably the strongest reason for the unpopularity of the graduate, who, because he possessed a degree, doubtless thought he was a full-fledged engineer.

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Experience through a sufficient length of time has vindicated systematic engineering education, but no small factor in such vindication has been the growth in the formerly vituperated graduate of the faculty of judgment, without which his education would have been of little avail, and the possession of which in a high degree enabled the early engineers with but little scholastic education to accomplish feats that remain the pride of the profession. Engineering education, in a broad sense does not, then, consist in merely a college education, for it implies the seasoning of the judgment, a seasoning that only comes from experience with practical affairs in which every exercise of the judgment is inexorably checked.

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Any attempt to impart this faculty of judgment to the youth at college would appear futile, and the graduate goes into the world rather as a candidate for engineer, using that term in its older sense, than as a full-fledged engineer, as his degree may lead him to believe. The engineering course would therefore appear to have for its object the teaching of principles, the time for which should not be entrenched upon by practical work that does not materially aid such teaching. For practical work in college shops and laboratories is not apt to have much influence on the judgment, and the practical instruction imparted will either not be utilized at all after graduation, or form but a very slender portion of what it is necesary to know in any line taken up profesionally. Every employer has his own methods, and every line of work its special features—as a rule, not arbitrarily fixed, but due to the conditions existing in each case. Consequently, the young graduate has necessarily a period of apprenticeship before him—a period in which he will learn in an infinitely more thorough manner all the practical details of the particular line of work upon which his livelihood is dependent. On the other hand, once graduated he will ordinarily have little opportunity and less desire to continue the systematic study of principle, the habit of mind for which is ideally created and maintained in the academic atmosphere of a college.

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## DESIGN OF A ¼ H.P. SINGLE-PHASE INDUCTION MOTOR.

BY P. M. HELDT.

The induction motor described in this article was designed to be built by amateurs, and the aim has been to make it simple and easy to construct.

The motor is designed for a single-phase alternating circuit of 104 volts and a frequency of 60 cycles per second. It has four poles, and, therefore, its synchronous speed would be 1800 revolutions per minute. The actual speed of the motor at load will be about 10 per cent less than the synchronous speed.

The primary or stator has a plain ring winding, and the secondary or rotor a so-called cage winding, consisting of bare copper conductors, embedded without insulation in an iron core, all conductors being connected at the ends. The bearing supports are provided with an oil chamber, and either a ring or felt self-oiler may be used.

In making the calculations for the motor we will follow the method much used in transformer calculation, which consists in assuming the various losses, and from these losses determine the dimensions of the parts in which they occur. We will set down the efficiency of our machine at 60 per cent and the power factor at 75, figures which obtain in machines of this size on the market. The output being ¼ h.p., or 186 watts, the intake will be $\frac{186}{.6} = 310$ watts, and the total losses are, therefore, 124 watts. We will make a preliminary division of this loss as follows:

Primary $C^2R$ loss, 25 watts.
Secondary $C^2R$ loss, 15 watts.
Hysteresis, 40 watts.
Friction and eddycurrents, 34 watts.

The primary current at full load will be $\frac{310}{140 \times .75} = 4$ amperes. From the $C^2R$ loss and the current strength we may now find the resistance of the primary circuit, $R = \frac{25}{4^2} = 1.56$ ohms.

Alowing a current density in the primary winding of 2000 amperes per sq. in., we find that the wire to be used is No. 16 B. & S. The length of this wire, which will have a resistance, when warm, of 1.56 ohms, is 354 ft.

The ohmic component of the e.m.f. in the primary circuit is 1.56x4 = 6.24 volts, and the induction or counter e.m.f., therefore $\sqrt{104^2 + 6.24^2 - 2 \times 104 \times 6.24 \times .75} = 99.42$ volts.

In a single-phase induction motor the strength of the rotating field is not constant, but fluctuates. We will base our calculations, however, on an equivalent rotating field of constant strength.

Fig. 1 shows a diagram of the magnetic field in the motor. Let N be the flux of magnetism that passes through the teeth of the stator, between A and B. Then, as the magnetic field rotates with a velocity of 1800 r.p.m., and the conductors are stationary, each conductor cuts this number of lines 120 times per second. The mean value of the e.m.f. induced in one conductor will be $\frac{N \times 120}{10^8}$, and the $\sqrt{}$ mean square, $\frac{N \times 120 \times 1.1}{10^8}$ But this value, multiplied by the number of conductors, is the maximum e.m.f. induced in the primary winding. Representing by n the number of cycles per second (60), we may write:

$$E\sqrt{2} = \frac{2.2\ n\ N\ C}{10^8} \quad (1)$$

We will allow a maximum magnetic density in the stator core of 25,000 lines to the sq. in., and make the axial width of the core double its radial depth. The maximum magnetic flux at any cross section of the core is $\frac{N}{2}$. The area of the cross section will, therefore, be $\frac{N}{50000}$. The periphery of this area is $6\sqrt{\frac{N}{100000}}$ and taking the length of turn 10 per cent greater than the periphery of the core, we have for it the value, $l = 6.6\sqrt{\frac{N}{100000}}$.

The number of conductors is equal to the total length of wire divided by the length of one turn:

$$C = \frac{L}{6.6\sqrt{\frac{N}{100000}}}$$

By substituting this value of C in equation (1), transforming and reducing, we obtain

$$N = \frac{1.8\ E^2.\ 10^{12}}{n^2\ L^2}$$

We may now substitute as follows: E = 99.4, n = 60, L = 4248 (inches). This gives N = 275000.

The magnetic cross section of the field core is $\frac{N}{50000} = 5.5$ sq. in., and the length of one turn, $6.6\sqrt{\frac{N}{100000}} = 11$ ins.

The number of conductors is $\frac{4248}{11} = 386$. As we have four poles, the number of conductors should be divisible by four, and we will, therefore, take 384 conductors.

These conductors may be distributed in 32 slots, giving 12 conductors per slot. We will wind these conductors 2 wide and 6 deep. The diameter of No. 16 double cotton-covered magnet wire is 61 mils. For insulation we allow 30 mils on each side of the slot and 30 mils at the bottom; also a clearance space of 30 mils below the surface of the teeth. This gives for the dimensions of the slots a depth of 426 mils and a width of 182 mils.

The cross sectional area of the core was 5.5 sq. ins., and the ratio of axial length to radial depth, 100. We will make the core 3½ ins. long by 1 9/16 ins. deep, which approximately satisfies the above two conditions.

The mean magnetic density in the teeth may be taken at 32,000 lines per sq. in. There are in all 550,000 lines, each passing through the teeth twice, which is equivalent to 1,100,000 passing once. The magnetic cross section of the teeth should, therefore, be $\frac{1,100000}{32000} = 34.4$ sq. ins. Dividing this area by 3.5 ins., the length of the teeth, we obtain 9.83 ins., the circumferential space taken up by the teeth. The circumferential space taken up by the slots is $32 \times .182 = 5.82$ ins. The total inner circumference of the stator is, therefore, 15.65 ins., and the diameter practically 5 ins.

Some of the lines of force that pass through the primary circuit do not enter the secondary circuit, but leak around it. The leakage coefficient is about 1.2. The total lines of force crossing the gap number, therefore, $\frac{1,100000}{1.2} = 916.600$. By dividing this number by the surface of the gap we obtain the mean magnetic density in it, $\frac{916.600}{55} = 16600$

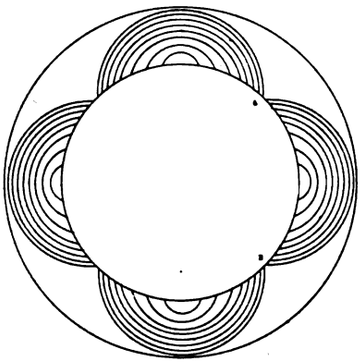


FIG. 1.—MAGNETIC CIRCUIT.

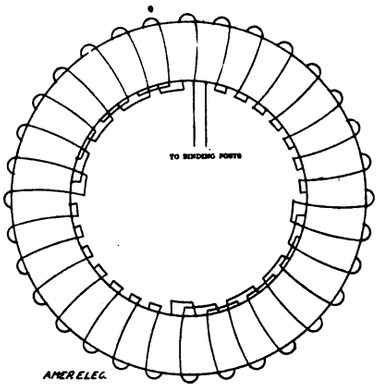



FIG. 2.—DIAGRAM OF STATOR WINDING.

The output of our motor is 186 watts, and the allowance for friction 30 watts. The total energy transformed from the electrical to the mechanical state is, therefore, 216 watts. The $C^2R$ loss in the secondary is 15 watts. It is a well-known fact that the ratio of the motor speed to the speed of synchronism is the same as the ratio between the energy transformed in the secondary to the energy absorbed by it. The speed of our motor at load will, therefore, $\frac{2161}{23}$. 1800 = 1680 r.p.m. When a rotor be of 5 ins. diameter, running at 1680 r.p.m., develops mechanical energy at the rate of 216 watts, the tangential force on its circumference is 4.34 lbs. Now a conductor a inches in length, carrying an alternating current whose $\sqrt{}$ mean square value is I in a sinusoidal field of mean intensity, B has

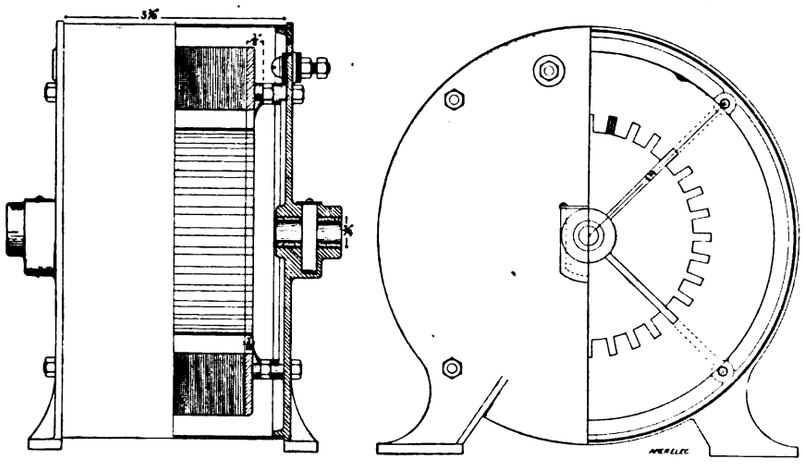
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a mean force of $\frac{I\,a\,B}{10180000}$ lbs. exerted on it. If there be C conductors, the force is $\frac{C\,I\,a\,B}{10180000}$ lbs. We may substitute the values of a and B and equate this expression to our circumferential force,

$$\frac{C\,I \cdot 3.5.16600}{10180000} = 4.34$$

$$C\,I = 760$$

The number of secondary conductors, multiplied by the amperes per conductor is, therefore, 760. We will put 15 conductors on the secondary, which will give a current of a little over 50 amps. per conductor. The loss in each conductor is one watt, and the resistance per conductor, therefore, $\frac{1}{2500}$ ohm. This includes, of course, the resistance of the soldered joints and the return on the ends, which cannot be exactly calculated, but which may be taken at one-half of the total, so that the actual resistance of the conductor is only $\frac{1}{5000}$ ohm. The size of wire of which a length of 3½ ins. has a resistance of $\frac{1}{5000}$ ohm is No. 8 B. & S., which we will use for the cage winding of the motor. The maximum density of our equivalent rotating field of constant strength was 25,000 lines per square inch. We have to make a small allowance for the insulation of the discs, and also take into account the fact that our actual rotating field is fluctuating, which subjects parts of the core to a considerably higher magnetic density. At 35,000 lines per square inch the hysteresis loss per cubic foot at 60 cycles is 360 watts. There are 129 cubic in. of iron in the stator core below the teeth, and the hysteresis loss would, therefore, be 28 watts. In the teeth the magnetic density will reach 60,000 lines per square inch. The hysteresis loss at this density and frequency is 840 watts per cu. ft. There are 17 cu. ins. of iron in the teeth, and the hysteresis loss is, therefore, 8.5 watts. In the rotor the hysteresis loss is practically nil, as the frequency of the reversal of magnetism is proportional to the slip of the rotor, which at full load is only one-fifteenth the frequency of reversal of the magnetism in the stator core. Our total hysteresis loss is, therefore, 36.5 watts, which is well within the limit of our allowance for it.



FIGS. 3 AND 4.—END AND SIDE ELEVATION, HALF IN SECTION.

### CONSTRUCTION OF MOTOR.

The construction of the motor will now be explained, reference being had to the accompanying drawings. As the motor is symmetrical in both vertical planes, the drawings of the stator show it part in full view and part in section.

The stator is built up of discs stamped from No. 27 transformer iron. These discs have an internal diameter of 5 ins. and an external diameter of 9 ins. They should be varnished on one side with an insulating varnish, thinned down so as to form a thin, uniform coating on the surface of the discs. The discs must be dried before being assembled. Two disc-shaped brass castings of the same internal and external diameter as the discs and a thickness of 3/16 ins. serve as end plates. These castings have four lugs on the outer edge, strengthened by ribs. Through these lugs the clamping rods pass.

A round piece of sheet iron, 10 ins. in diameter, should be procured, from which to make a templet. Find the center of the sheet iron and lay out a circle of 4 5/8 ins. radius. Divide the circumference into four equal parts and centermark the division points. Drill the center and the division joints on the circle with a small drill. (About No. 40.) This templet is clamped on the brass castings so that the holes on the circle come about over the center of the lugs. With the same small drill used before a hole should now be drilled through the brass casting. These holes are then enlarged with a ¼-in. drill. The clamping rods are ¼-in., either Bessemer or cold-rolled steel rods, cut off to 6¼-ins. With a ¼-in. standard die a thread is cut on each end of the rod to a distance of 1¼ ins.

The disc may now be assembled. The clamping rods are not strong enough to properly compress the discs, and this should be done under a drill press or in a vise while the nuts are tightened up. Enough discs must be put on to make the length 3½ ins. when tightened up. After the core has been put together it should be chucked in a lathe and a light cut taken out of it to make the inner diameter 5 1/64 ins. Care must be taken not to make the bore too large, as this would much reduce the efficiency and capacity of the motor.

The rotor is built up of discs of the same material as the stator, ⅝ in. internal diameter and 5 ins. external diameter. Two disc-shaped brass castings serve as end plates. The hole in the center of these castings should be finished to ⅝ ins.

The shaft is turned up from a piece of cold-rolled steel of ¾-in. diameter. The middle part of the shaft is turned to such a diameter that the discs fit over it and the ends so as to be a running fit in a ½-in. hole. A ⅝-in. thread is cut on each end of the middle part of the shaft.

The discs for the rotor need not be insulated but can be built right up on the shaft and clamped by the two hexagon nuts shown in the drawing. A hole is drilled into the shaft through the end plates, as shown, and a steel rod or round spike is driven into the hole and sawed off. The rotor is now put into a milling machine,

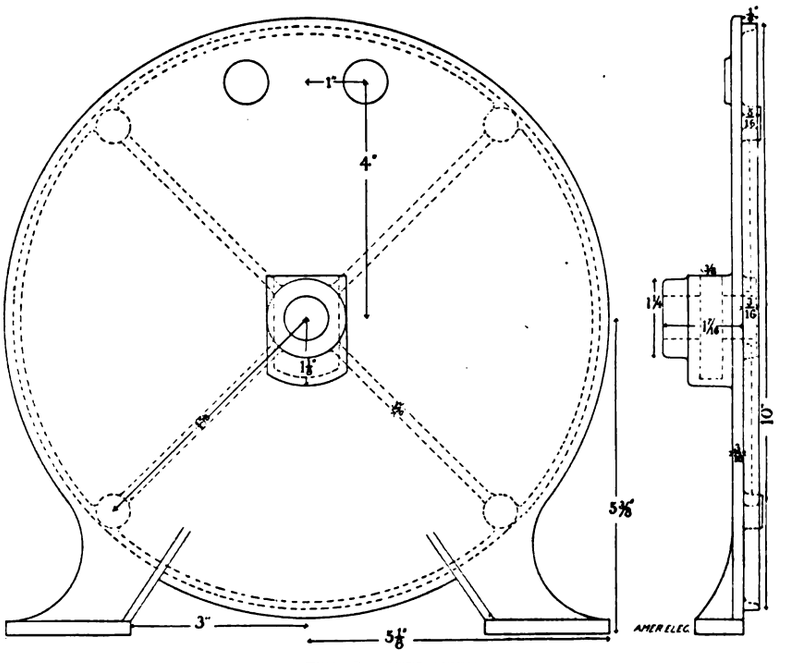



FIG. 5.—END DISC.

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and, with a ⅛-in. milling cutter, 15 slots are cut 3/16 in. deep. The No. 8 copper wires have to be driven into these slots. They are soldered at the ends to the brass end plates, the solder being applied liberally and made to fill up all around the wire. The rotor should now be put in a lathe and turned down to a diameter of 4 63/64 ins. Care must also be exercised here to avoid taking too large a cut. While the rotor is in the lathe, the nuts on the shaft are turned to ⅜ in. in length.

We now take the bearing supports, and by means of our templet drill the holes for the clamping rods. In fastening the templet to the castings the centers should be made to coincide. In one of the castings two ⅜-in. holes for the binding screws are drilled through the center of the bosses provided for this purpose. A piece of soft wood is cut that will fit into the oil chamber. A ½-in. hole is drilled through this piece of wood, through which the shaft may pass.

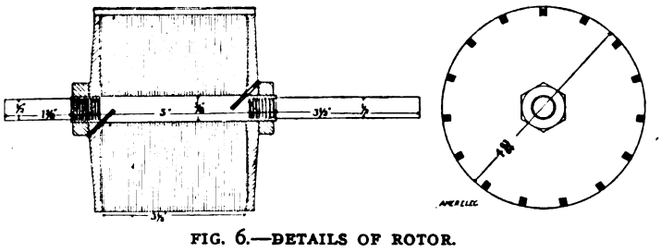


FIG. 6.—DETAILS OF ROTOR.

The rotor is now wrapped with paper until it fits tightly in the stator. It is put in place and the bearing supports are slipped on with the wood in place in the oil chambers. The bearing supports are fastened down by means of nuts on the clamping rods. Some babbitt metal should now be melted in a ladle, the motor set on end and the outer parts of the bearings filled with babbitt. The bearing supports should now be marked so that they can be put on the same way again after they have been taken off. Take off the bearing supports, reverse the shaft through them and fill up the remaining end with babbitt. The ends of the babbitt lining should now be trimmed up, the bearings put back on the core and a ½-in. reamer run through them.

We now take the stator core and put it in a shaper to cut the slots. The slots are 182 mils wide and 426 mils deep, and there are 32 of them equally spaced around the inner circumference of the stator core. After the slots have been cut, all the sharp edges are rounded off with a file and the core is cleaned of all iron dust and grease. The insulation is next put on. Shellac dissolved in alcohol is the best insulating substance to stick the insulating material to the core. Two thicknesses of pressboard, 15 mils thick should be used in the slots, the troughs being made about ⅛ in. longer than the core. The ends and outside of the core are insulated in the same manner as ordinary direct-current armatures, and it will not be necessary to describe this specially. Any one not familiar with the method of insulating armature cores may refer to the descriptions of small motors that have appeared in recent issues of the AMERICAN ELECTRICIAN.

The wire is wound in the slots two wide and six deep, while on the outside of the core it is wound only two deep. The coils are connected as shown in the diagram. In the first eight coils the ending of one coil is connected to the beginning of the next. The ending of the eighth coil is connected to the ending of the ninth, the beginning of the ninth to the end of the tenth and so on until the sixteenth. The beginning of the sixteenth is connected to the beginning of the seventeenth, the end of the seventeenth to the beginning of the eighteenth, and so on to the twenty-fourth, where the connections are changed again. The beginning and ending of the whole winding are brought out to the binding posts. These consist of ¼-in. round-head machine screws, 1¼ inches long, passing through the bearing support, being insulated from it by fiber washers and bushings. A tube of sheet iron is made, 10 ins. diameter and 5 ins. long, which will just fit over the circular offset on the bearing supports and serve to protect the windings of the stator. This completes every part of our motor, and it may now be assembled.

The motor is not self-starting, and has to be brought up to speed by some external means. If the bearings are well aligned, as they should be, a vigorous start by hand on the pulley will be sufficient to make the motor pick up. The motor should be started immediately the current is turned on, and for this reason a switch should be placed convenient to the motor.

## AMERICAN TELEPHONE PRACTICE.

### THE COMMON RETURN SYSTEM.

BY KEMPSTER B. MILLER.

Where a number of lines radiate from a central point to a number of subscribers' stations, the cheapest way of arranging the circuits, if expense alone is to be considered, is to make each a grounded circuit. This is done by grounding each line at the subscribers' station after it has passed through the telephone there, and also at the central office after it has passed through the coil of the annunciator or signalling device. Such an arrangement is shown in Fig. 1, and it may be assumed that the lines there shown run in the same direction —on the same poles or in the same cable— to the various subscribers which they serve. In each case D is the line drop at the central office, and R represents the entire telephone set at the several subscribers' stations.

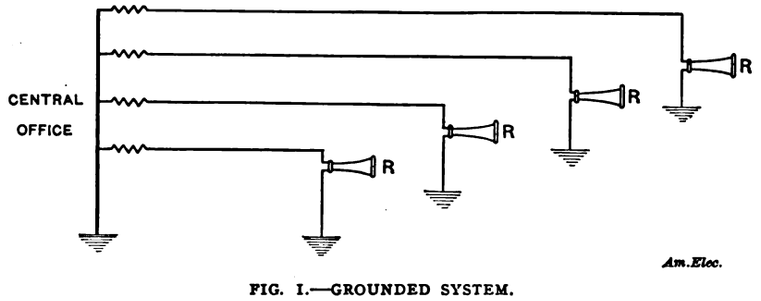



FIG. 1.—GROUNDED SYSTEM.

It is evident that with such an arrangement, disturbances in the receivers may be produced by any one or all of the causes already considered. An electric light or power wire, carrying a heavy current may cause trouble by electrostatic or electromagnetic induction, or by leakage; and moreover, each telephone wire, when in use, may be a disturbing wire to all of the others.

As has been pointed out, the proper remedy for these disturbances is to make each line a separate metallic circuit, and to properly transpose the two sides of each circuit at frequent intervals where the lines are long. This course is followed in most large telephone exchanges, and many small ones; but it frequently happens that commercial considerations will not allow it in smaller installations. Where this is the case a system called the common return or McCluer system is frequently used, with excellent results. The layout is the same as that of the grounded system, with the exception that the return of every circuit is made through a heavy wire common to all of the circuits. A clear conception of the common return system may be had by considering a heavy wire, Fig. 2, to take the place of the earth in a grounded system; each line wire being connected to it at or near the subscribers' station after passing through the telephone instrument R, and at the exchange after passing through the switchboard drop D.

It is quite evident that the common return system will, if properly installed, remove all trouble due to leakage or earth currents; for the entire system of wiring may be kept highly insulated from the ground and from other conductors. Practice, however, differs to a large extent in this respect, as some companies ground the common return wire at the exchange, and also at several other points along its length, others at the exchange only, while others keep it entirely insulated from earth. Probably the reason for placing several grounds on the return wire is to effect a reduction in the resistance of the return path, but this, if needed, should be brought about in another way. Probably the

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best practice in most cases is to keep entirely free from grounds, although there are many who claim to have effected a marked improvement by heavily grounding the common return at the central office. At any rate, this is an easy experiment to try. The location of the common return wire with respect to the other wires on the poles, is a question concerning which there is much difference of opinion. Undoubtedly the best way of disposing it, so far as the purely electrical considerations are concerned, is to place it on brackets between the two middle cross arms on the poles, for then it bears a more symmetrical position with respect to all of the line wires and is, therefore, better adapted to neutralize induction from outside sources. It is, however, often put on other parts of the pole, sometimes above all the wires, sometimes on a bracket just below the top cross arm, and frequently below the lowest cross arm. The latter is probably the most convenient place, as wires led off to buildings will usually stand clear of the other wires on the pole.

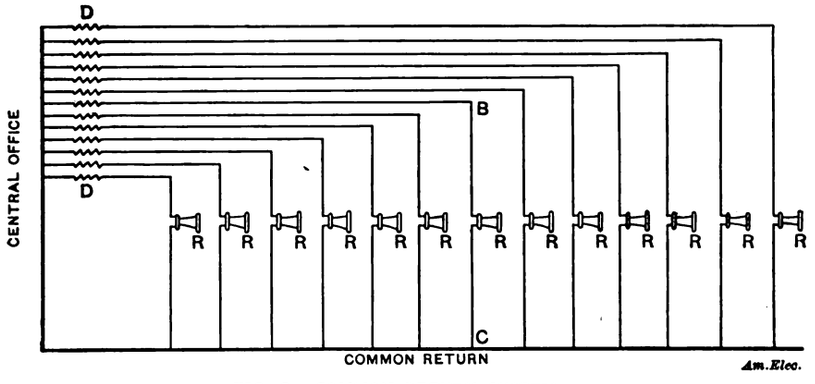



FIG. 2.—COMMON RETURN SYSTEM.

There is even more difference of opinion as to the proper size of the common return wire, than its location. An analysis of the inductive action from neighboring wires may perhaps throw some light upon the subject. If we assume that the entire system is insulated from the ground and from other conductors, it will be safe to say that all disturbances in the telephones due to leakage or earth currents will be eliminated. The only way, therefore, by which neighboring wires can affect the telephone wires is by induction, and this may be either electromagnetic or electrostatic, or both. The ideal arrangement of the common return wire with respect to the line wires would be that in which all were at an equal distance from the disturbing wire. This condition can only be roughly approximated in practice, but in Fig. 3 it will be assumed that the disturbing wire, which may be a trolley or electric light line, is at approximately the same distance from the line wires 1 and 2 and from the return wire CR. The lines 1 and 2 are connected together at central by the cord circuit C, a clearing-out drop being bridged between the cord and the common return, and the line drops DD cut out as in ordinary practice.

It is evident that if no sounds are to be produced in the receiver of line 1, the points A and B must be of equal potential. Similarly the points a and b must be of equal potential for no disturbance to be produced in the receiver of line 2, and the points C and C¹ for no current to flow through the clearing-out drop. It matters not if C, a and A are all of different potentials, the one requisite for silence in the receivers being that the two points at the terminals of each shall be of the same potential. The question, therefore, becomes, what size of wire shall be used for the common return in order to bring about these conditions?

Considering the induction from the disturbing wire to be electromagnetic, it is evident that the electromotive force set up in the several wires will be proportional only to their lengths, as their distances from the disturbing wire is assumed to be the same in each case. The sizes of the wire will have nothing to do with the pressure developed, any more than the size of the wire *per se* affects the electromotive force developed in the armature winding of a dynamo. In the case of the wire 1 the e.m.f. generated in the length CA will equal that generated in the length C¹B of the common return wire. This means that the points A and B have the same potential as have also C and C¹, and no current will flow through the receiver of that line or the clearing-out drop. By the same reasoning the pressure developed in length Ca of line 2 will equal that in the length C¹b of the common return, and no current will flow through the receiver of line 2. So far as electromagnetic induction is concerned, therefore, the size of the common return wire is immaterial.

Considering the question from the standpoint of electrostatic induction, it will be seen that for a given charge on the disturbing wire charges of the same potential will be induced on each of the line wires and on the common return wire. There will, perhaps, be a slight tendency for the small wires to assume charges of slightly higher potential than the larger wire, on account of their smaller radius of curvature, but this would be so slight as to be negligible under the conditions assumed, and would be eliminated were the common return wire made of the same size as the line wires.

So far as inductive disturbances from outside sources are concerned, it seems that the size of the common return wire is practically immaterial, with perhaps a slight theoretical advantage to be gained by making it of the same size as the line wires. In as much as this view is at direct variance with all written statements I have seen on the subject, it is put forward with hesitation.

The same reasoning will show that when any one of the telephone lines is considered as the disturbing wire, the same conclusions are reached.

So far no valid reason has been shown for making the common return larger than the line wires. There is, however, a good reason why this should be done, and this is the fact that the return circuit of any one wire, is made not only through the common return wire, but also through all of the other line wires in multiple. Referring to Fig. 2, it is evident that currents generated in line ABC may find a return path through the common return wire, and through all of the other wires in multiple. In fact all of these return paths will be chosen, the current dividing among the other line wires and common return, inversely as to their respective impedances.

The current flowing through these other lines would produce cross talk were they of sufficient magnitude to do so, and the only way of preventing this is to make the common return wire of such low resistance that practically all of the current will pass through it. The fact that the common return wire may be made to possess practically no self induction, and, therefore, only the impedance due to its ohmic resistance; while the line wires all include in their circuits either the receiver and induction coils or the bell and drop coils, serves to divert nearly all of the current through the common return wire, where it belongs. On account of the marvelous sensitiveness of even poor receivers, a comparatively small resistance in the common return will shunt enough current through the various instruments to cause cross talk to a considerable extent.

There is undoubtedly a large amount of copper wasted in common return wires, and it is probable that a No. 8 B. & S. gage

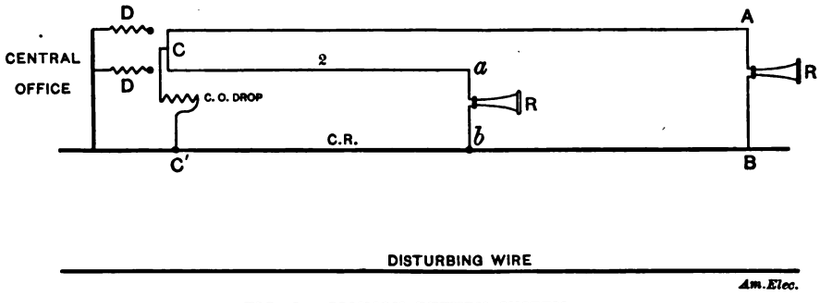



FIG. 3.—COMMON RETURN SYSTEM.

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copper will in most cases answer the purpose. It too frequently happens that larger common return wires are used in the hope of remedying a difficulty which is due to another cause entirely. Cross talk in switchboards and office cables is often attributed to the smallness of the return wire, which in this case might be increased indefinitely without improving the service.

Of course, the ideal conditions assumed for the disposition of the wires cannot be attained, and in so far as they are not attained, induction is likely to occur.

## INTERIOR WIRING.

### BRANCH CIRCUITS AND CALCULATION OF CONDUCTORS.

BY CHAS. E. KNOX.

The lights having been satisfactorily located in the preceding article in the building selected, the next thing for consideration is to arrange the branch circuit work. It is presumed that the lights have been located in conference with the architect. If this be the case, the next thing to settle with him would be the location of the distributing centers, the point where the mains may rise and to determine what space is available for the branch circuit conduits.

Taking up the first of these points, we have assumed that the current will enter the rear of the house. We will therefore place the main distributing center on the rear wall of the cellar. Here the service switch and meter may be placed without taking any space that is likely to be useful for other purposes. It can readily be seen by inspection, that one center of distribution will be ample for each of the upper floors. A good central for these groups of cut-outs is shown in Figs. 2 and 3. (See February number.) Being placed in the stair hall, they have the advantage of being accessible at all times without being obtrusive.

In regard to the rising point for the mains, no trouble will be found in a frame building of this kind, as space between the "studs" forming the frame-work for the partitions, can be utilized.

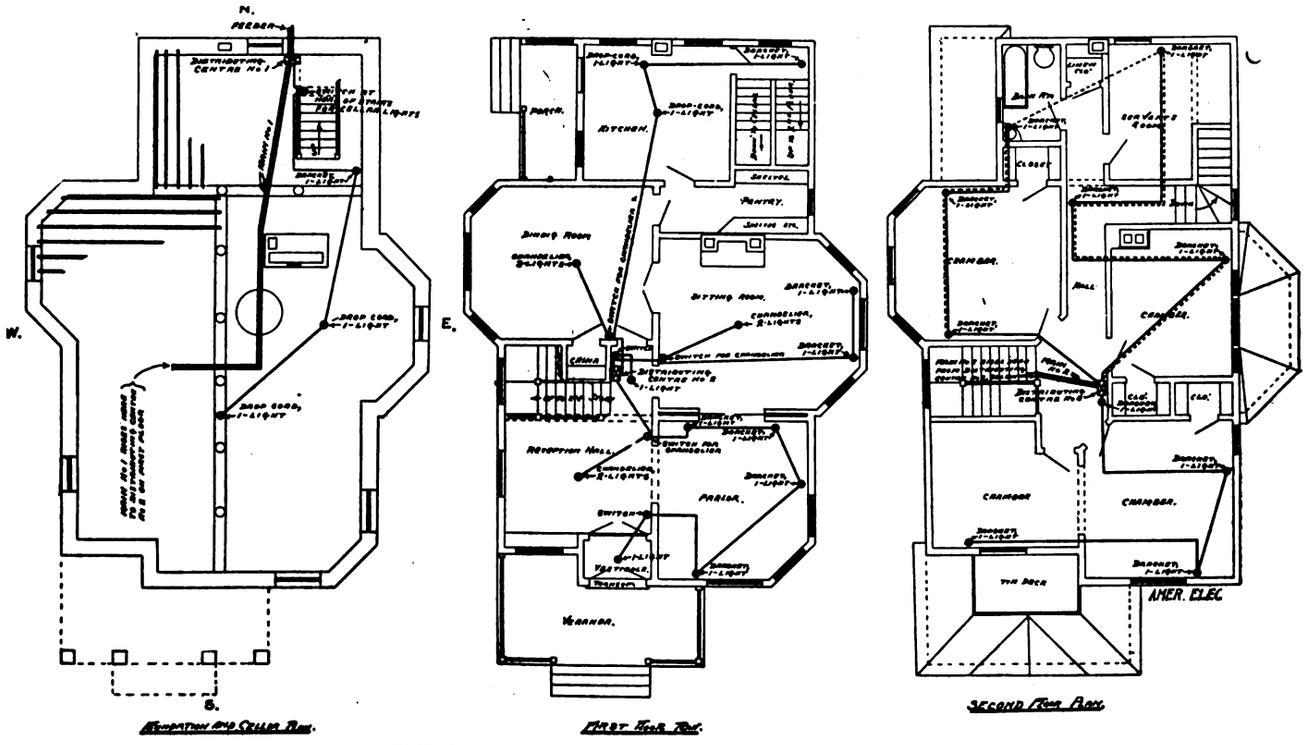
As to the available space for the branch circuits, no trouble will be found in placing these conduits if the beams are "furred" for lathing, as the conduits can run between the furring strips in one direction and between the beams and above the furring strips when they run in a direction perpendicular to the furring strips. If no furring strips are used, the beams will have to be notched for the conduits.

As to the exact course of the branch circuits from the distributing center to the various outlets, we will indicate the number of branch circuits, the grouping of the outlets on these circuits, but will not attempt to show the exact course or the location of the branch circuit conduits. Some years ago, a leading electrical engineer in New York City devised a very clever scheme where, by using characteristic lines and various symbols, not only the intended course, but the exact location of every conduit could be designated. There were also symbols representing the various kinds of outlets and even suggesting the kind of fixtures intended to be used. Notwithstanding the comprehensiveness of the scheme, it was so exceedingly simple, that any wireman could grasp it in a remarkably short time, by means of a schedule of symbols furnished with the plans. We will not attempt to do this here, because in the first place, it is beyond the scope of this article, and in the second place, the symbols and lines used for that particular purpose are copyrighted.

Coming back to the branch circuit work, let us commence with the cellar. Run one branch circuit from the cellar distributing center to the switch at the head of the cellar stairs and thence to the three outlets in the cellar, (see Figs. 1 and 2). This length of circuit would, of course, be shorter than it would be if the circuit originated at the first floor distributing center.

On the first floor we find there are fourteen outlets and eighteen lights. If we allow three circuits for these outlets, we will have an average of six lights to the circuit. We might get along with two circuits, but this would allow very little margin for increasing the number of lights. A fair grouping of the lights on three circuits is shown in Fig. 2. Where branches are shown here at switches (as in the dining room), it is intended that one portion of the circuit is controlled by the switch (in this case, the chandelier), the other portion being connected back of the switch and therefore not controlled by the switch. (See diagram in a previous article.)

On the second floor we have ten outlets, supplying a total of ten lights. Two circuits would be ample, so far as the number of lights is concerned. It is questionable, however, whether there would be any saving in having the lights arranged here in two circuits over their arrangement on three circuits. Figure 3 shows both arrangements; the grouping of the lights in the rear portion on two circuits being shown in full lines, and on one circuit in dotted lines. Of course, the circuit work could be shortened by "branching" at a light outlet, but for the reasons given in a preceding article, the objections to this offset the slight saving in cost.




FIGS. 1, 2 AND 3.—LOCATION OF LIGHTS AND CIRCUITS.

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The branch circuit work having been laid out, the next step is to arrange the feeder and main circuit work. In order to do this, a sectional elevation of the building should be obtained from the architect, showing the number and heights of stories. A section of the building under discussion is shown in Fig. 4. On this section indicate the distributing centers (diagrammatically) on each floor. Determine the number of lights fed directly through each distributing center. In this particular case there are three lights fed from the cellar (main) distributing center, eighteen from

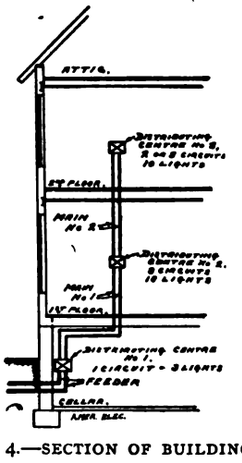



FIG. 4.—SECTION OF BUILDING.

the first floor and ten from the second floor distributing center. By inspection in this case it is readily apparent that one feeder with prolongations (mains) will be sufficient. As there are so few hall lights, of course no special provision need be made for them. Show the feeder and mains on the sectional elevation connecting the three centers (see Fig. 4). Then indicate them on the floor plans, following as closely as possible their definite proposed location (as their approximate length is necessary to determine their size). Then get the length of the mains from the plans and the elevation, allowing a certain percentage in addition to the calculated length for deviations, etc.

In this case we will assume that the length of the feeder from the transformer to the main distributing center is 150 ft. It will also be taken for granted that this feeder is to be supplied by the wiring contractor and not by the local lighting company. The lighting company will, of course, supply the transformer and the meter.

The remaining question to be settled is the amount of loss to be allowed from the transformer to the most distant lamp. Assume that this total loss is to be three volts. About one volt of this should be allowed for the branch circuits. If this be done, two volts remain to be divided between the feeder and mains. Suppose that of this amount, one volt be allowed for the feeder, six-tenths for main No. 1, and four-tenths for main No. 2.

With these assumptions, let us make a preliminary calculation of the sizes of wire required. If the results obtained from this allotment of the losses is not such as to give the best results at the least cost, a new apportionment of the losses and a second calculation should be made. Now summarize the data for the feeder and mains as follows:

Feeder, length, 150 ft.; load, 31 lights; loss allowed, one volt; main No. 1, length, 55 ft.; load, 28 lights; loss allowed, 6-10, (six-tenths); main No. 2, length 29 ft.; load, 10 lights; loss, 4-10, (four-tenths).

Using the formula, size in circular mills,

$$= \frac{\text{No. of lamps} \times \text{length in ft.} \times 11.42^{*}}{\text{drop in volts}}$$

we find the following sizes of wires: Feeder No. 4, B. & S. wire; main No. 1 = No. 6 B. & S. wire; main No. 2 = No. 12 B. & S. wire. As these sizes and losses make a good arrangement, we will adopt them.

This practically completes our task so far as the plans of this particular building are concerned, with the exception of the schedules.

Schedules present a very useful method for collecting all the data relating to the circuit work, and putting them in a concise form. It is well to have a schedule for the outlets and lights, giving the number of each kind of outlet on each floor with a summary of the total number of each kind on all the floors. A schedule of the feeders and mains, giving size of wire, length and loss in volts of the feeders and mains is almost essential. It is also well to make a schedule of branch circuits showing the number of outlets and lights supplied by each circuit, also a schedule of switches giving the outlets or circuits which they control.

## INDUCTIVE LOADS ON ALTERNATING CURRENT TRANSFORMERS.

At the recent Milwaukee meeting of the Northwestern Electrical Association, Prof. D. C. Jackson read a paper on the effect of inductive loads, such as arc lamps, on the regulation of secondary alternating current circuits, in which the importance of the question was illustrated by examples taken from practice.

As an illustration, three 5000-watt transformers for frequency of sixty were taken. Each had 2 per cent resistance drop at full load and the reactive drops were 3 per cent, 5 per cent and 7 per cent, respectively. A primary pressure of 1120 volts was assumed and a secondary pressure of 112 volts.

In the case of the first transformer, at full load the voltage at the secondary terminals would be reduced by reactive and ohmic drops to 109 volts. With a load of arc lamps having a power factor of .7, the secondary pressure would become 108 volts, thus giving a drop of four volts. In the case of the second transformer, the drop in the transformer would reduce the voltage to 109.6 volts, while with a load of arc lamps having a power factor of 7 per cent, the voltage would be reduced to 106.4 volts.

In the case of the third transformer, the secondary voltage would be 109.5 volts with a non-inductive load such as incandescent lamps. With a power factor of 50 per cent, which is sometimes met with in practice, the secondary voltage would be 104.1.

The above illustrations show clearly that it is necessary to use transformers with little reactive drop in case inductive loads are operated from the same transformers as incandescent lamps. Transformers with a frequency of 60 should be purchased with a guaranteed reactive drop not exceeding 5 per cent at full load in any size, and not exceeding 3 per cent at full load in the larger sizes. Many of the older transformers, Prof. Jackson stated, show a reactive drop with 60 frequency which exceeds 10 per cent at full load and some even approach 20 per cent. In the latter case, with a resistance drop at full load of 2 per cent, the secondary voltage with a full load of incandescent lamps would only be 105.5, or a drop of 4.5 per cent; while with a secondary load of arc lamps having a power factor of 70, the voltage would fall to 93.5. High frequencies cause the reactive drop to be increased, and Prof. Jackson believes it hardly possible to operate together arc lamps and incandescent lamps at a frequency of 133.

A determination of the reactive drop in a transformer may be made as follows:

Short circuit the secondary coil through an ammeter and connect the primary coil to a lighting circuit through a variable resistance. Adjust this resistance until a normal full load current is indicated by the ammeter. Then the reading of a voltmeter across the terminals of the primary coil gives the total drop of pressure. The resistance drop is found directly by dividing the copper loss of the transformer by the ammeter reading and the reactive drop then obtained by squaring the drop measured, subtracting from it the square of the resistance drop and taking the square root of the remainder.

Prof. Jackson stated that some arc lamps he has tested had a power factor as low as 50 per cent, which means that the transformer capacity required for such lamps is just twice as great as that required for incandescent lamps aggregating the same watts. The capacity of a transformer is measured by the current which passes through it and with the power factor of 50 per cent, half of this current is idle current. Lamps that are purchased should be tested by central station men for watts absorbed in the arc, watts absorbed by the lamp, as a whole, and volt-amperes absorbed by the lamp. This, he states, is a matter of a few minutes' work, providing the necessary instruments are available.

## SAVING BY THE THREE WIRE SYSTEM.

ALTON D. ADAMS.

A well-known rule of electric circuits is that the weight of copper required to transmit a given amount of energy at a certain percent of loss varies as the square of the pressure at which the transmission takes place for any given distance.

Recently a writer, evidently not in accord with this rule, has stated that "the actual

*The constant for 104-volt 16-c.p. lamps.

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saving in wire by the use of the three-wire system is one-fourth when the neutral wire is made the same size as the outside wires, and when an equal drop is considered," and again, "these two reductions then constitute a total reduction of area to one-fourth the original size, but the loss in the two systems will not be the same if this process is carried out."

Now the purpose and use of the three-wire system is to double the pressure or volts at which electric energy is distributed to incandescent lamps so that for the common cases with the 110-volt lamp and 10 per cent loss of energy on the two and three-wire systems, the two-wire pressure would be $110 \div .9 = 122.22$ volts, and the three-wire pressure, $2\ (110) \div .9 = 244.44$ volts at the dynamo.

According to the law above stated the weight of copper required for the three-wire system is three eighths of that for the two-wire for the same number of lamps and loss of energy in each system, allowing the neutral wire to be of the same size as each of the outside wires.

To make clear the several factors involved in each case, Figs. 1 and 2 are used to show the arrangement of each system for the same number of lamps. When all lamps are burning on the three-wire system the neutral wire does not convey energy either to or from the lamps, and it

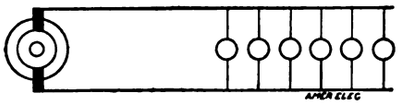


FIG. 1.—TWO-WIRE SYSTEM.

might be disconnected at the dynamo without changing conditions in the system.

If, however, at any time more lamps are connected to one outside wire and the neutral than to the other outside and the neutral, the neutral comes into use as will be shown hereafter.

The size of the neutral wire for any three-wire system is usually made the same as that of the outside wires, but this is simply a good guess as to the amount of work the neutral wire may be called on to do; again, the neutral is frequently made equal in size to the sum of the outside wires, especially in buildings, so that a change can be made to the two-wire system if desired by connecting the two outside wires as one and the double size neutral as the other.

The subject of direct calculation in the three-wire as in the two-wire system is the size of the two outside wires, and the size can be shown to be but one-fourth as great for the three as the two-wire system for the same energy loss.

Consider the case of 100 110-volt, 0.5 amp. lamps connected on the two-wire, also on the three-wire system under conditions of 10 per cent loss above stated.

The amperes flowing in the two-wire system are $100 \times .5 = 50$, and as the dynamo pressure 122.2 minus the lamp pressure 110 is lost in wiring, the watts consumed in wiring are $12.2 \times 50 = 610.0$. As in the three-wire system current passes from one-half of the lamps to the other half, the required current is but one-half as great as that for the two-wire system, so that for the present case the current in three-wire system is $50 \times .5 = 25$. amps., while the volts lost are $244.4 - 220 = 24.4$, making the watts consumed $24.4 \times 25 = 610.0$, the same as in the two-wire system, for the same percent of loss.

It should be noted that, though the total variation in pressure for the same percent of loss is twice as great in the three as in the two-wire system, yet the variation of pressure at each lamp, or between either

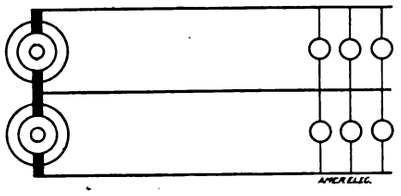


FIG. 2.—THREE-WIRE SYSTEM.

outside wire and the neutral is the same as that of the two-wire system; thus the pressure between the neutral and either of the dynamo terminals in above case is $244.4 \div 2 = 122.2$ volts, or just that of the two-wire system, and of this 122.2 volts, 12.2 volts are lost in the outside wire from either half of the lamps to the dynamo, this being the same loss as in the two-wire system.

Having proved above, that, for a given number of lamps, equal energy is lost in each system when the total drop in pressure in the three-wire is twice that in the two-wire system, the next step is to show the relative area and weight of two conductors, one of which is designed to conduct one-half the amperes with double the applied volts of the other, each having the same length.

Taking first the two-wire mains with current in them of 50 amps. and pressure loss of 12.2 volts, by the formula amperes = volts ÷ ohms., $50 = 12.2 \div$ ohms., so that, ohms. $= 12.2 \div 50 = 0.244$; that is, the two-wire mains must have a resistance of

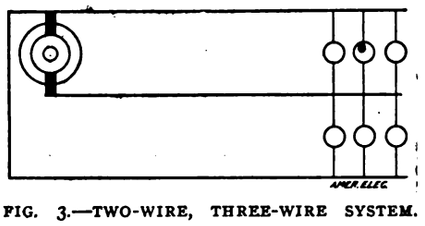


FIG. 3.—TWO-WIRE, THREE-WIRE SYSTEM.

0.244 ohms. The three-wire mains have in them current of 25 amps. at 24.4 volts, so that $25 = 24.4 \div$ ohms., or ohms. $= 24.4 \div 25 = 0.976$, from which the relative resistance of the three-wire to the two-wire mains is $.976 \div .244 = 4$ to 1, or the resistance of the three-wire mains is four times that of the two-wire mains for the same number of lamps, distance and loss of power. Taking 11 ohms as the resistance of a copper wire 1 ft. long and 1 mill diameter, the size of wire in circular mills for the two-wire mains is found from $0.244 = 11\ L \div$ c.m. or c.m. $= 11\ L \div .244$, from which c.m. $= 45.08\ L$, in which L is the total length of wire in mains.

The three-wire mains having a resistance of 0.976 ohms require a section of c.m. $= 11\ L \div .976 = 11.27\ L$.

Now the relative area of conductors for the three-wire and the two-wire system is, from the above, $11.27\ L \div 45.08\ L = \frac{1}{4}$, and as for the same length weight varies directly with area, the weight of conductors is only one-quarter as great for the three-wire as for the two-wire system, length, lamp load and loss of power being the same in each case, and provided no third wire is required. If the third or neutral wire is made the same size as either of the outside wires, it must have one-half their combined weight, which is $.25 \div 2 = .125$ of the weight of the two-wire system, so that all three wires of the three-wire system weigh $.25 + .125 = .375$, or three-eighths the weight of the two-wire system. If the neutral wire is made twice the size of each outside wire the weight of copper for the system will be $0.25 + 0.25 = .5$ of the weight for the two-wire system. Should a three-wire system, having the neutral twice either outside wire in size, be connected as shown in Fig. 3, with the neutral wire to one dynamo terminal and the two outside wires at the other, the loss of pressure or volts and of watts in the mains will be twice as great as when the system is connected up

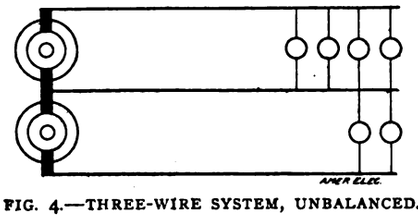


FIG. 4.—THREE-WIRE SYSTEM, UNBALANCED.

on the three-wire plan. This will be evident when it is considered that the amperes, volts, and therefore watts lost in the two outside wires remains the same in the two as in the three-wire connection, and in the two-wire there is an additional and equal loss in the neutral wire, since it then carries as many amperes as the other two.

In Fig. 4 is shown a case where the neutral of the three-wire system comes into use, as there are only one-half as many lamps between the positive and neutral wire as between the negative and neutral; in this case the positive and neutral wires each take about the same number of amperes to the lamps, and the sum of the amperes in these two wires flows toward the dynamos through the negative wire, this results in poor regulation at the lamps.

Were there no loss in the mains and feeders of the three-wire system, the pressure at lamps would be constant no matter how great the difference in the number of lamps between each outside wire and the neutral, but as there is loss in any practical system of wiring, perfect regulation cannot be had, the volts being too high between the outside and neutral wire where the less number of lamps are connected and low between the outside and neutral wire, where the greater number of lamps are connected. This lack of regulation forms one of the greatest objections to the use of the three-wire system, and central stations take precautions to have the loads on both sides the neutral as nearly equal as possible.

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## STEAM AND WATER STOP VALVES.

### GLOBE VALVES.

Probably this is the most widely known form of valve that is used in present engineering practice. It is a good form of valve as far as simplicity and cost are concerned. Its one great defect is the deflection of current through it, not only once, but twice. When the stream of water strikes the valve diaphragm, it is not only turned from the direction it was following when it entered the pipe, but the stream or current, or some parts of it, are actually reversed so that they must flow in exactly the opposite direction from which they first entered the valve. And in leaving the valve, some of the fluid or gas is actually reversed in direction again. The loss of pressure caused by the above actions is considerable and goes far to offset the advantages of simplicity and cheapness mentioned above. Indeed, the tendency of engineering is toward the use of gate instead of globe valves for all purposes. But this is a mistake. There is certain work for which the globe valve is best suited, and the gate valve will not hold such work for any length of time. There are fields for both valves and they will surely find their proper fields—and hold them.

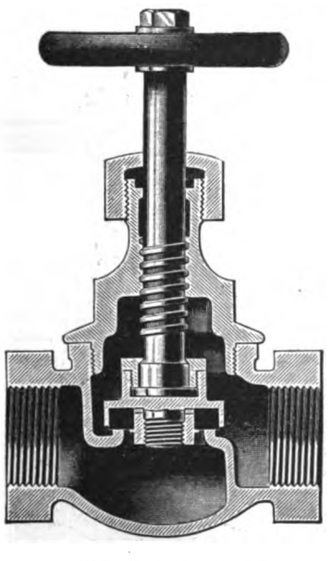


FIG. 1.—THE JENKINS GLOBE VALVE.

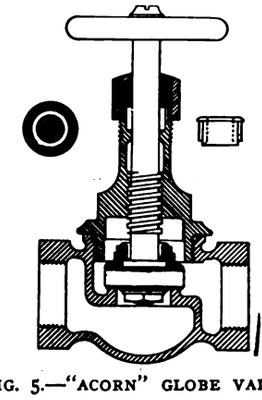
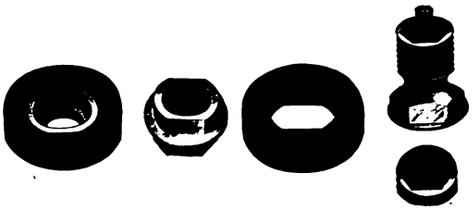


FIG. 5.—"ACORN" GLOBE VALVE.

A well-known form of globe valve is shown in the engraving presented in Fig. 1. It shows a sectional view of the Jenkins Bros. valve, in which the following distinctive peculiarities may be noted: The opening of the valve is considerable. The stem has a long travel, thus bringing the disc a considerable distance from the seat when the valve is fully open. This construction in a valve allows the passing matter to flow straight through the opening in the seat without having to make a quick turn under the disc, which acts as a baffle-plate to deflect the flow across the seat, thereby subjecting that portion of the valve to much more wear and cutting action than in a valve like that shown in the engraving, having a good deal of lift. In fact, a valve with a low lift of disc is—or its cutting action is—like a valve that is only partially open. We all know how a globe valve works which is used constantly for throttling purposes—it doesn't last long. The high lift of this valve tends to lengthen the life of the seat—and the disc as well.

The disc used with these valves is also well known, but there is one or two peculiarities that all engineers may not be aware of. Fig. 2 shows this disc, also the manner in which it is held in place by a nut which not only allows the packing to be easily removed, but actually removes it when the nut is taken off. Another peculiarity is in the packing ring. It was designed for a packing which would not be spoiled the first time sand or other dirt was caught between the disc and seat, but would yield and let the foreign matter press into the disc without doing much damage. Another thing about the packing which is there, but was not searched for, is that the packing material has a very great ratio of expansion as compared with brass. It is owing to this, that if a Jenkins valve be closed when very hot, it will leak a very little as soon as it gets cold. The packing contracts more than the body of the valve. It is for this reason that engineers, after closing a valve, always return to it after a short time and give the hand wheel another slight movement. The inexperienced engineer would at once screw the valve down tight when he closed it, thereby spoiling the disc the very first time it was used. This or any other valve should, on being closed, have the disc and seat barely touched together, and never forced together with great pressure by bull strength and stupidity on the hand wheel.

Another characteristic of this valve is the method of arranging the packing and gland nut so that the latter cannot be turned by



FIGS. 2 AND 3.—JENKINS DISC AND LOCK-NUT, AND KEYED STUFFING BOX.



FIG. 7.—DETACHABLE DISC.

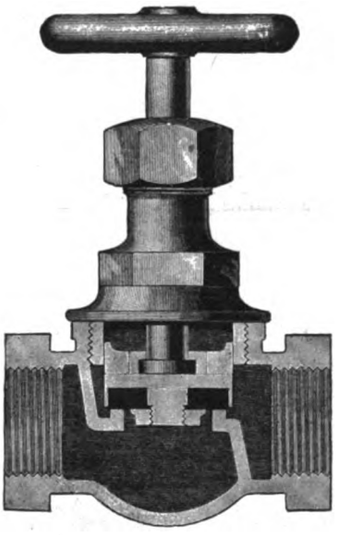


FIG. 6.—RENEWABLE DISC VALVE.

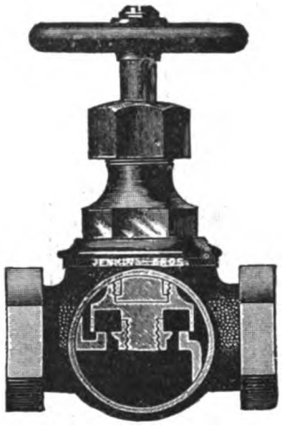


FIG. 4.—SCOTT-JENKINS GLOBE VALVE.

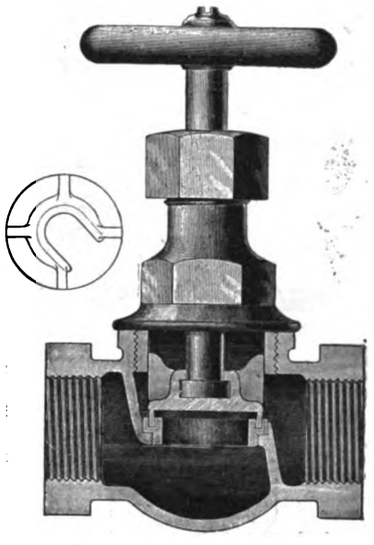


FIG. 8.—RENEWABLE SEAT VALVE.

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the stem imparting motion to the packing and thence to the nut. Fig. 3 shows the "keyed stuffing box," which is made by shaping the packing box into a hexagonal form instead of leaving it round as is the usual manner. As there can be no communication of motion between the stem and the nut through the packing, there is little chance of the nut being turned off when opening the valve—a great nuisance with some of the older forms of valves.

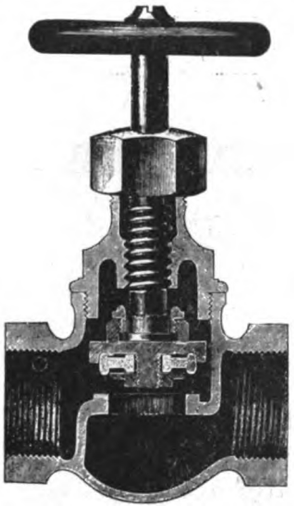


FIG. 9.—COPPER DISC VALVE.

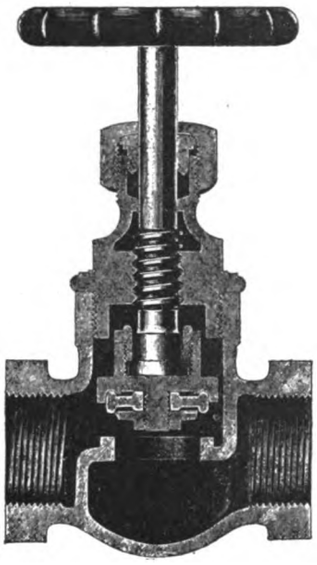


FIG. 10.—HEAVY COPPER DISC VALVE.

A valve made upon the same lines as the one described above is represented by Fig. 4. This—the Scott-Jenkins globe valve—is made by the Roe Stephens Manufacturing Company, and is a Jenkins valve to all intents and purposes, using the same packing and built in pretty much the same manner.

The valve illustrated by Fig. 5 is known as the "Oakes' acorn" globe valve, and is

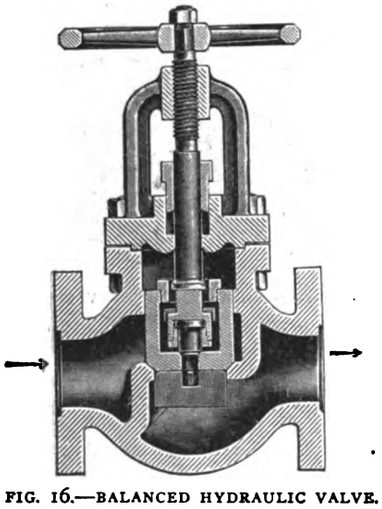


FIG. 16.—BALANCED HYDRAULIC VALVE.

manufactured by Thomas G. Oakes. The principal feature of this valve is the locked gland in the bonnet, as shown by the detail engravings. The packing does not bear directly against the nut, but is forced down by a gland which carries two lugs, which in turn engage corresponding shallow slots in the body of the valve casting. All valves above and including three-quarters inch are made with the gland above described.

When the brass to brass seat and disc valve is not used, some provision must be made for the renewal of the discs, for they are not expected to last any great length of time if there is a passage of dirt or of any other foreign substance in the water or steam. In the valve already described it may be noted that the discs are renewed by taking out a packing washer and replacing it with a new one. In the valve shown by Fig. 6 the entire disc is removed and replaced by a new one, and the packing washer in the disc may then be renewed at pleasure. By removing the bonnet of the valve the disc can be taken out without the further use of tools. There are guides attached to the disc which slide on the inside surface of the bonnet of the valve, forming a positive guide for the disc so that it strikes squarely upon the seat.

A view of the disc detached is given by Fig. 7, and the manner of its connection with the valve stem is plainly shown. These valves are represented as remaining perfectly tight under all moderate pressures of steam, oil or gas, but for very high pressures, the manufacturer, the Kennedy Valve



FIGS. 11, 12 AND 13.—SWIVEL GLAND, STUFFING BOX AND COPPER DISC.

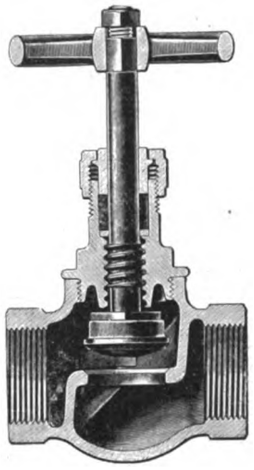


FIG. 14.—SOLID SEAT AND DISC VALVE.

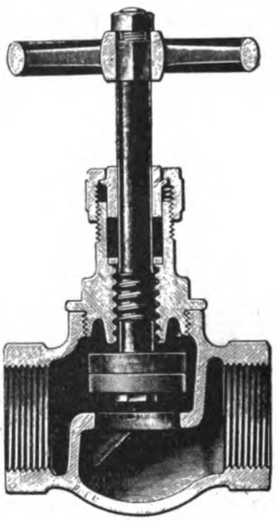


FIG. 15.—LEATHER DISC VALVE.

Manufacturing Company, claims its novel feature to be in the renewable seat, instead of in a renewable disc. As shown by Fig. 8, the seat consists of a ring made of annealed copper, slightly wedge shaped and held firmly in position by the screw nipple into which the ring is inserted. The change is made by unscrewing the bushing above mentioned and inserting a new one. All this can be done by simply removing the bonnet of the valve.

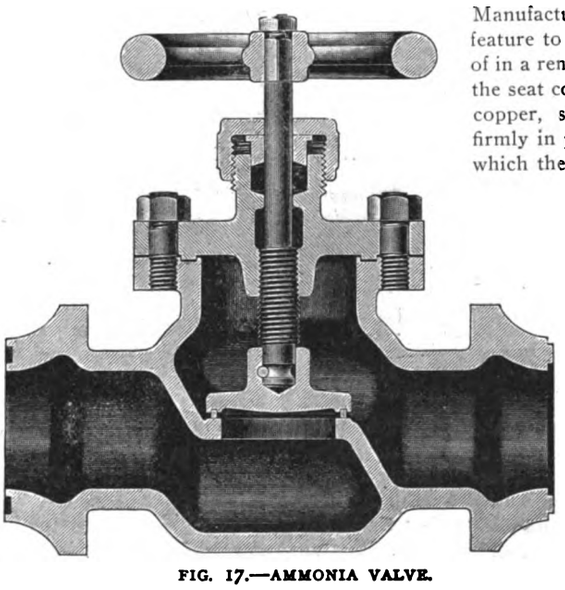


FIG. 17.—AMMONIA VALVE.

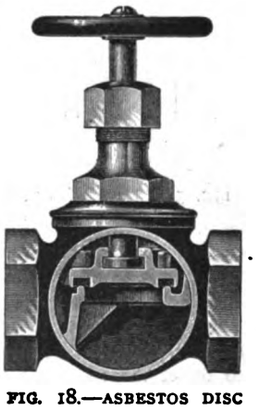


FIG. 18.—ASBESTOS DISC VALVE.

Copper seems to be a favorite substance for use in making tight valves, and in the form illustrated by Fig. 9 the disc is made of that metal. The disc is also reversible,

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and when one side becomes worn or damaged it may be turned over and used again in that position. This valve is made by the Crane company, who also make the heavy form of valve shown by Fig. 10. This also has the reversible copper disc which is attached as shown. It will also be seen that there is a rounded backing which engages the under side of the bonnet when the stem is screwed out to its fullest extent for the purpose of renewing the packing. Fig. 10 also shows the manner in which the stuffing box is constructed.

The Crane valves, or at least when so ordered, are fitted with a peculiar swivel gland stuffing box as illustrated by Fig. 11. By this form of gland the pressure is always square against the packing, and there is none of that sidewise twisting business which must take place to a certain extent whenever the nut bears directly against the packing. Figs. 12 and 13 show details of the copper disc, also of the nut which holds the disc, and its manner of application to the disc and to the stem.

Figs. 14, 15 and 16 illustrate three valves made by the Eynon-Evans Manufacturing Company. These valves are the ordinary globe, the leather disc, with bronze body for acid waters—in the coal districts—and the balanced hydraulic globe valve, made for pressures of 250, 750 and 2,500 lbs. per sq. in. This valve, it is claimed, is made heavy enough to stand the pressure, and cheapness is made a secondary consideration. The lift of disc is quite short, but the area of opening between seat and disc is about 1¼ times the area of the pipe to which the valve will be attached.

The construction of the leather disc valve is so plainly shown by the engraving that little further description is necessary. All these valves may be packed around the stem while under pressure, without leakage, as the engravings plainly show.

The balanced hydraulic valve, Fig. 16, has its disc relieved of pressure by a close fit between the elongated disc and the walls of the cavity in the bonnet. Then the cavity, thus shut off by the disc, is connected with the discharge side of the valve by means of a suitable passage vertically

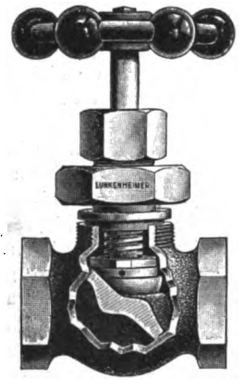


FIG. 19.—LUNKENHEIMER REGRINDING VALVE.

through the disc of the valve. No matter then, how high the pressure runs in either inlet or outlet sides of the valve, the disc—or plunger, as it may appropriately be called—must always move as easily as if there was no pressure at all against the valve.

Another form of high pressure valve is shown by Fig. 17, in which the type well known as an "ammonia valve" is illustrated. The bonnet is bolted on, instead of being screwed, and the stem is fitted with a very heavy gland and a follower, both being so beveled that the stem packing is forced against the stem, rather than squarely downward.

The valve shown by Fig. 18 is made by the Fairbanks Company, and is fitted with a disc, the wearing surface of which is vulcanized asbestos. It is claimed that the asbestos as used in these valves will not crack or flake off, thereby making a very durable packing. The discs, as shown by the detail engravings, are not screwed to the stem, but by removing the bonnet, the old disc may be removed and a new one put on in a very few seconds.

Several types of regrinding globe valves are on the market, and the following engravings show representative types of them. Fig. 19 is the Lunkenheimer, made by the

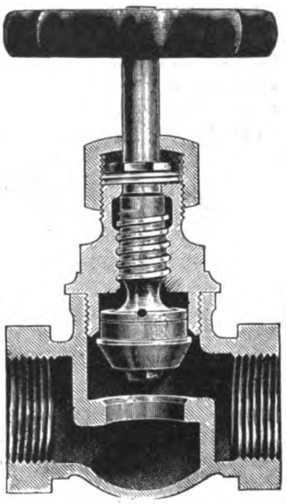


FIG. 20.—"EXCELSIOR" REGRINDING VALVE.

Lunkenheimer Company. Unlike most valves, the hub is not threaded and screwed directly into the valve shell. Instead, there is a union nut which screws over the body and clamps the bonnet to the body by means of a flat ring on the former, which lies on top of the body. By loosening the union nut, the stem may be rotated without working the thread, and if a bit of wire be put through the small hole in the disc, that will be held rigid with the stem, and the valve may be reground with a little soap and powdered sand on the disc. After this mixture is put on, replace the trimming, but leave the union nut loose. The hub will rotate and guide the stem while regrinding the seat bearing.

Fig. 20 shows another regrinding valve—the "Excelsior" made by the Kelly & Jones Company. The disc is made of a special hard alloy. By removing the bonnet and inserting a pin in hole shown in engraving, the disc is locked to the stem. The bonnet thread is then re-entered about one thread in neck of valve, when the stem may be run down until the thread is disengaged from bonnet. The valve can then be reground without further manipulation.

Still another regrinding valve, the "Star" valve, made by the William Powell Com-

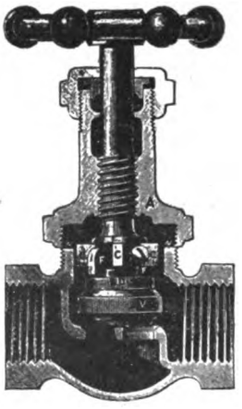


FIG. 21.—"STAR" REGRINDING VALVE.

pany, is the subject of engraving No. 21. It is claimed that this is the original of all lockable loose disc valves, and it certainly requires no pieces of wire to be inserted in order to lock the disc for regrinding. A lock-bar is contained complete in each valve, and to use it it is only necessary to release the bonnet and the stem can be taken out for inspection. A half turn of the set-screw will release the lock-bar, which will then drop into the slot in the disc and may be fastened there by the same screw.

After regrinding, return the lock-bar to its original position and fasten it there with the set-screw. Wings are provided which guide the disc and prevent all side motion to cause undue wear to the seat. This company also makes another form of globe valve—not regrinding—which carries the regular Jenkins disc packing.

## ECONOMY OF STEAM PRODUCTION.

BY A. L. HARRISON.

Continuing on the line of the latter part of the article in the February issue, I wish to call attention to a quite prevalent error as to the economy of labor due to "mechanical stokers." If the coal must be shoveled into the hopper, it will require quite as much labor per given number of boilers operated as when hand-fired furnaces are used. If coal-handling machinery be properly placed in connection, there is some labor saved, but not to the extent usually claimed by interested parties. The attempt to save labor in this connection is sometimes carried to such an extent as to preclude the possibility of proper attention being given to the fires, and in such cases the waste of fuel and extra repairs more than offset the economy in labor.

It cannot be too strongly impressed on all interested that no mechanical furnace will run itself, but must have more or less intelligent attention and supervision to keep the fires from becoming too thick, or so thin as to burn holes in the fire through which excess air rushes, destroying econ

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omy. Then there is attention required to feed water, by the damper and other details too often neglected with consequent reduction of economy.

I have called attention to the labor item that I may take it plain that whatever economy may be secured by saving of labor in handling either coal or ashes mechanically, is due to and properly credited up to use of conveyers, bins, chutes, etc., and not to the "stoker," only so far as the stoker may help to make handling machinery practical.

The type of mechanical stoker known as the "automatic furnace" differs from each of the other types in almost every important practical feature. The specially unique feature of this form, however, consists in its being self-cleaning as well as self-stoking, thereby making it not only a different type of "stoker," but also a distinct class; or, in other words, an "automatic furnace," rather than a "mechanical stoker;" but, like the other "stokers," this furnace will not run itself without intelligent supervision, and while the work is less laborious, because there is little or no cleaning, there can be no reduction in the number of attendants in small plants, and not to exceed one in four in large plants without loss in efficiency, unless handling machinery is attached. The economy, therefore, to justify the extra cost for any mechanical furnace must be found in the fuel economy that can be realized after deducting the cost in fuel represented by the steam used to operate the mechanism, which, in some cases where live steam jets are used to "kill the smoke," amounts to fully 15 per cent of the steam produced.

No reader should wrongly construe the above as intended to discourage the use of mechanical furnaces. On the contrary, it is intended to encourage intelligent selection and thereby promote the use of such as can show real every day economy of fuel sufficient to justify the extra cost of installation as compared with the ordinary or hand-fired forms. The labor saving and other utility features then become additional inducements, and the economy should promote a quite general use of the best in both small and large plants.

Mechanical furnaces, in common with all new or improved forms of mechanisms, suffer from the representations made by those who think only of securing a present sale, and who, to secure it, lead their customer to expect what can by no means be realized, and the result is disappointment.

A dissatisfied user seldom appreciates the actual benefits, and in cases where a crude or ill-devised form has been "worked off" on a user, he becomes soured and condemns indiscriminately all mechanical furnaces. This accounts for so many intelligent owners of steam plants holding strenuously to such ideas as is indicated by the following quoted declarations: "No furnace can beat hand-firing." "No stoker can be crowded." "All of them will smoke if you try to crowd." Such statements come principally from three distinct classes of persons, the class whose knowledge is second-hand and unreliable; those who have become soured by having been "taken in" by a good talker, or who failed to get proper results by reason of lack of intelligent methods; and, last, but not least, those who from self-interest in an inferior form are trying to hold up their own by lowering the plane of merit due other and more meritorious forms.

As it is natural for all persons of "shady" moral practices to decry the existence of real excellence, so those who are interested in a second or third-grade mechanism naturally decry the existence of a mechanism of like designed purpose which is possessed of unusual merit. Much of the prejudice existing against use of the mechanical furnaces is due to the chatter of those who profess to have a new and improved form which, in fact, is only a modification of old or discarded forms, and which modification is in no practical sense an improvement.

It certainly is no credit to a mechanical engineer to be spending either his time or his employer's money experimenting with forms which knowledge of "the state of the art" would condemn on sight. How is the average man to know how to get at it so as to make an intelligent selection? Just as the average business man gets at intelligent selection of any other important system or mechanism for the promotion of his business interests.

One reason why so many fatal mistakes have been made in this particular line is the fact that so many business men consult those who are supposed to know, and ought to know, but who actually do not know enough about the actual "state of the art" to know what the experience has been, and know so little about the vital requirements necessary to constitute possible practical success that they are more frequently led into indorsing a failure, or only partial success, than they are instrumental in promoting the use of a furnace which will reflect credit on their professional knowledge, and be a continued satisfaction to their client.

The following quotation: "It will burn more coal per square foot of grate and give more steam per pound of coal, more steam per square foot of heating surface, raise steam more readily and maintain any given gage pressure more steadily, whether the load be regular or irregular, than any other form of furnace," is taken from the circular issued and distributed by one of the established concerns which manufactures a mechanical furnace, and is either intentionally misleading, or it is an important fact which every consulting engineer worthy the name should know.

How many consulting engineers know—remember, I say *know*—whether this declaration is in any sense substantially true or not?

I do not say this to discredit the profession, but to emphasize the lamented fact that no proper attention is given, even by those whose profession requires it, to the proper construction and arrangement of a boiler furnace.

In proof of this assertion I might cite the fact that as yet no engineer or other authority on mechanical subjects has ever attempted to publicly discuss the merits of "stokers" or mechanical furnaces in anything like a thorough manner, or so as to impart definite information as to the exact "state of the art," or the special difficulties experienced or possible benefits to be realized. There has been no discussion along this line in the American Society of Mechanical Engineers' meetings beyond the occasional reading of a paper usually dealing in generalities or based upon exact knowledge of but a single type.

Only about a year since a considerable portion of the time of no less than three sessions of the Franklin Institute was gravely occupied listening to papers read by representatives of "smoke preventing appliances," most of which would not bear intelligent discussion; and there was no discussion of either the meritorious or unmeritorious, presumably because the members had not sufficient knowledge of the subject to venture to discuss it.

It is for the purpose of stirring up the profession to a proper appreciation of the importance of this question of the possible economics to be realized by a more intelligent use of scientific knowledge relating to combustion, and of the facts of experience in the burning of "steam" coal, that I have thus called attention to these facts which are prima facie evidence of a lack of knowledge, and of a lack of a proper disposition and energy to acquire the knowledge, necessary to wisely promote improvement along this line.

## ELECTRIC RAILWAY PRACTICE.

### COMMUTATORS—THEIR CARE AND REPAIR.

BY JOS. H. SMITH.

In the early days of the electric motor commutators were not considered a very important factor in their construction. The segments were thin and small and very poorly insulated, mostly with paper, and when one gave out it was thrown in the scrap and a new one substituted.

Now everything is changed. When the inspector examines a motor for trouble, he first looks at the commutator, and in most cases by its condition can tell where the fault lies. To-day, then, the commutator receives that respect from the designer and repair men which is its due, with the consequence that most of them last about three years.

In this article some hints will be given on the care and repair of commutators, but it should be borne in mind that strict attention to the former will prevent a too frequent application of the latter.

No rule can be given to govern all circumstances, or how often a commutator should be turned or sandpapered, so this will be left to the inspector's judgment. For sandpapering a commutator in a motor a block of wood should be cut the width of the commutator and as long as the distance between the brush holders will permit. A semicircle should be cut in this of the same arc as the commutator, and a handle fastened to the back of the block. No. 2½ is the proper sandpaper to use, cut into strips the right width and

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tacked on the ends, allowing slack enough to set well in the circle. The car should be run at a very high speed, as this will give a smooth surface and clean the commutator quickly.

Wipe the commutator free from the flint and copper dust and apply a cloth with a very little vaseline, which should be wiped off with a clean cloth. Be sure and remove the brushes before sandpapering. The brushes should not be allowed to wear down excessively, as the tension then becomes weaker, and they will spark. Brush holders should set about one-quarter of an inch from the commutator. Springs should not be so tight as to wear a brush out in a couple of days, as this wears the commutator unnecessarily.

When all the segments turn black it should be seen that the springs are not too weak, or that the commutator is not worn out. If only a few of them are black, clean the mica cone and band rings with sandpaper and look for loose joints. A round-nose tool should be used in turning down a commutator, and run with a slow feed. Avoid square corners on commutators which have no bead ring, as a square corner leaves a jumping point for the current. Bead rings should be cleaned and painted with insulating japan very often; shellac should not be used. When string is used it should be treated in a like manner.

To clean a commutator remove it from the shaft and place it on an arbor setting horizontally in a vice. Clean the face of the segments with sandpaper, and place a band of paper around them, over which place a thin steel band two inches wide and about one inch shorter in length than the circumference of the commutator. The ends should be turned up at right angles to the ring and reinforced with a piece about one-quarter of an inch thick, riveted to them, drilled and threaded to receive a long screw to draw the ends together.

When the segments are held together tightly with the band, the bolts or clamping ring should be taken off and the ring of segments removed. These should be cleaned inside and on the ends, and then tested with the terminals of a four-light circuit, going over every segment; if the current runs across from one segment to another, clean that spot until it is clear. After putting the commutator together, set up the bolts and test again.

If the old mica cone or band rings are used they must be cleaned on the surface with fine sandpaper. Test for a ground with a wire direct from the trolley with a fuse in circuit. A commutator cleaned in this manner is as good as new.

When soldering with a blow lamp or torch, use great care and try and heat all the segments as near alike as possible, as an uneven heat changes the temper of some of the segments and makes them wear faster than others.

A very good method of soldering is to cut the solder into blocks about quarter of an inch square, place them over the leads, and just heat enough applied to melt them. The surplus solder is rubbed off with a cloth. A very good flux is made from powdered rosin dissolved in turpentine or alcohol; acid should never be used. The mica should be cleaned with a hack saw blade after soldering.

In replacing either a copper or mica segment, tie a rope around the commutator and remove the clamping ring; then loosen the rope enough to remove the defective segment, and also a good one for a pattern. If it is a mica segment take a square piece of mica as large as the segment and of the right thickness, and place this with a copper segment in a vise, with the mica in front; file toward the copper, which acts as a backing and prevents the mica from splitting or tearing. Clamp the two together with a hand vise when changing the position in the vise.

If a cut in the mica is not very bad, or time is precious, mix a paste of soapstone or slate grated on a file with shellac and apply heat and smoothe with a file.

When changing or repairing a mica band ring, and it cannot be put on whole, cut it once and split into three layers on each side of the cut for about 3 ins.; then cut the layer off the first one 3 ins. from the end, the second one 2 ins., and the third 1 in.; cut the other side in like manner, only reversing the order of cutting, so that they will lap over each other and be of the same thickness in the joint.

Do not cut the mica off square and bring the ends together, for if it does not fit well, or is too small, there will be an air space; and if too large it will wrinkle.

In fitting new brushes to an old commutator see that the face of the brush has a good contact. Place a lighted match behind the brush, and the light will show where the brush does not touch; then file to fit.

## *Lessons in Practical Electricity*

CALCULATION OF ALTERNATING CURRENTS.

In this and a succeeding article will be illustrated the manner in which the apparently involved methods for the calculation of alternating current phenomena arise; that is, the origin of the terms angle of lag, phase difference, vector addition, etc. In order to fix more clearly the ideas involved, a numerical case will be taken.

Suppose we have an inductance in an alternating current circuit. This inductance we will assume to be a choke coil having a resistance of .5-ohm and a coefficient and self-inductance of 1 millihenry. We will also assume that the alternating current has a frequency of 125 periods per second; that is, there are 15,000 alternations per minute. Suppose, further, that 10 amps. as measured by an ammeter pass through the coil, and that it is desired to know the e.m.f. between its terminals when this amount of current is flowing.

Having once assumed a sine variation of e.m.f. and current, but a single point is needed in order to construct the curve representing this variation. Thus, referring to Fig. 1, if we know the maximum voltage or current, O D, the sine curve can be laid down as follows:

Having assumed the current to be 10 amps., the maximum value of the current will be 1.7 times this, or 17 amps. To any scale lay down the circle O M, drawn with a radius 17; then divide the semi-circumference into a number of equal parts, A, B, C, etc.; and from these points let fall the perpendiculars, Aa, Bb, Cc, etc. Next, divide a horizontal line, M N, whose length is equal to the length of the semi-circumference of the circle, into as many equal divisions as the circumference has been divided, and transfer the lengths of the perpendiculars to corresponding divisions on this line, which will give us the lines Aa, Bb, etc. Through these points, draw the curve M B D F N, which will be the sine curve for a half-period. This can then be duplicated below the line to the right for the remaining half-period, as shown.

Referring to Fig. 2, suppose that we have in this manner laid down to scale the current curve, C. We wish now to obtain the curves showing the drop in the coil due to resistance, and the curve showing the drop in the coil due to inductance; the resultant of these two curves will then be the impressed e.m.f., which is the quantity desired.

To determine the first curve, since the maximum current flowing is 17 amps., and the resistance of the coil is .5-ohm, the maximum ordinate will be C R = 8.5 volts. Moreover, since the resistance drop will be greatest when the value of the current is greatest and zero when the current is at zero, the corresponding curve will follow the variations of the current curve; in other words, will be a sine curve and in phase with the current curve. Laying down, therefore, the ordinate L R equal to 8.5, we have the maximum ordinate of the sine curve and the remaining portion may be obtained by means of the circle construction, as given in Fig. 1.

To obtain the inductance curve, it must be borne in mind that the inductive e.m.f. is caused by the cutting in and out of the coil of lines of force due to changes in the current flowing, and that the more rapid the rate of this cutting, the higher will be the inductive e.m.f. At any instant the number of lines of force within the coil depends upon the value of the current flowing therein. It will be seen by reference to the current curve, that the current, and therefore lines of force change in value least rapidly at the peak and most rapidly when passing through zero. In fact at the instant of passing through the peak, the rate change of current and therefore of cutting of lines becomes zero, and, consequently, at this instant the inductive e.m.f. will be zero. On the other hand, when the current curve passes through zero, its rate of change, and, consequently, the rate of change of the lines of force in the coil due to the current, is greatest and at this point the inductive e.m.f. will be greatest. That is to say, the zero of the inductive e.m.f. will be on the same perpendicular as the maximum of the current, and the former

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will be on the same line with the zero of the current curve.

Knowing the frequency, self-inductance and current, we can calculate the e.m.f. from the formula, $E = \frac{2\pi n L C}{1000}$ substituting $L = 1$, $n = 125$ and $C = 17$, we have for the inductive e.m.f. 13 volts, which is the maximum ordinate since we have used the maximum value of current. The curve of inductive e.m.f. can now be laid down in the same manner as that of the resistance e.m.f.

The impressed e.m.f. is the e.m.f. required to overcome the sum of the resistance and inductive e.m.fs. At the point N, for example, the resistance e.m.f. is N R', while the inductive e.m.f. is N L'. Since, however, one of these is below the line and the other is above the line, their algebraic sum or the impressed e.m.f. required to overcome the two, is the arithmetical difference between the two, which is N E'. At the point L, since the inductive e.m.f. is zero, the impressed e.m.f. is equal to the value of the resistance e.m.f. at that point, or equal to L R. In this manner we can proceed and obtain the algebraic sum at each point of the resistance and inductive e.m.fs., which sum will be the value of the impressed e.m.f. at that point. By this means we can get the curve E, having a maximum value of 15, which is the curve of impressed e.m.f., and this maximum value divided by 1.7 will be the e.m.f. that would be measured at the binding-posts of the coil by a voltmeter, or 8.8 volts. The scale of Fig. 2 does not altogether conform to the above data, but the diagram nevertheless serves to fix the ideas; the actual value of the impressed e.m.f. was found by calculation, as will be explained in the next lesson, but by a correct geometrical construction could have been measured from the diagram.

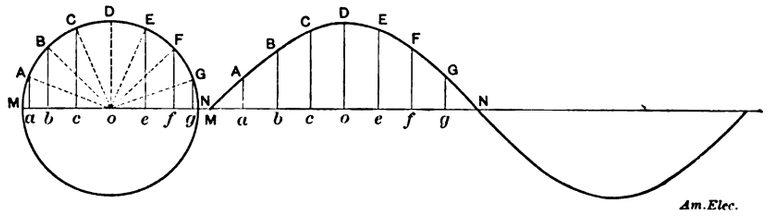



FIG. 1.—CONSTRUCTION OF SINE CURVE.

Referring to Fig. 2, it will be seen that at S and Q the resistance e.m.f. and current curves cut the horizontal line at the same point, and they are, therefore, said to be in phase. Considering that the earlier it is in time the earlier a curve cuts the horizontal line to the left, it will be seen that both the inductive and impressed e.m.fs. cut this line ahead of the current curve; or, in other words, the current lags behind both the inductive and impressed e.m.fs. In the case of the inductive e.m.f., this lag will be seen to always amount to one-half a semi-period, while the lag of the current behind the impressed e.m.f. is about one-half of this.

The exact amount of the latter may be determined by measuring the lengths of the distance K S, and of the distance S P, representing an entire period. Then the ratio of the former to the latter will be the lag in fraction of an entire period. Or, if the length S P is named 360 deg., then the lag K S expressed in degrees will be 360 multiplied by the ratio above found. In the present case, the current lags behind the impressed e.m.f. by about one-eleventh of a period, or 33 degs. As Fig. 2 shows, however, there is really no angle involved, the condition actually existing being merely that the current and impressed e.m.f. do not reach their maximum or minimum values at the same time, being thrown out of phase a definite amount by the inductive e.m.f.

It will be noticed, that since the inductive e.m.f. is at zero when the current is at a maximum, and vice versa, the corresponding curves must differ in phase by a quarter-period; or, if we call an entire period 360 degs., the phase difference is 90 degs.; or, in still more mathematical language, the current and inductive e.m.f. are in quadrature; or, in still other terms, they are quarter-phased, and so on—the duplication of nomenclature arising to a great extent from the anxiety of a certain class of writers to appear original.

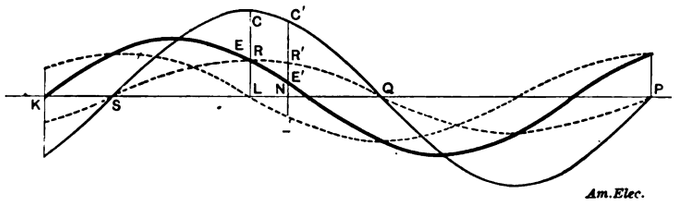



FIG. 2.—DETERMINATION OF IMPRESSED E.M.F.

From the above we see that when we consider alternating currents in a direct manner, we may add and subtract alternating voltages and currents precisely as in the case of direct-currents. It would, however, be entirely impracticable in each case to make such a construction as that shown, and therefore, the artifice is adopted which brings in angles, vector addition and the other artificialities which make alternating currents so puzzling to the beginner. If one at the beginning accepts the language and methods referred to as due to artificial conditions adopted in order to facilitate calculations, he should have no difficulty in a clear understanding of the phenomena which otherwise would naturally be a mystery to him. In the next article will be considered the application of the mathematical properties of the sine curve, by means of which alternating current calculations are enormously simplified.

## TWO-RATE CHARGING FROM THE CONSUMER'S STANDPOINT.

BY LYMAN C. REED.

Two-rate charging for current is quite a recent development in electric practice, and arises from the conditions presented by the load line of the central stations which supply current for light and power purposes. In central stations, as a rule, there is an abnormal amount of current to be supplied from about 4 P. M. until 9 P. M., and at some time between these hours the "peak" of the load line reaches its highest point. The plant has to have sufficient capacity in boilers and engines to meet the demand, notwithstanding the fact that the mean load line seldom averages over one-third of the maximum demand.

In order to try to even up the load line —that is, to make the demand on the plant as nearly uniform as possible each hour of the twenty-four—two rates have been much in favor in some localities, the purpose being to encourage the use of current when the demand on the plant is light and to discourage the use of current when the peak of the load is on. An even load line would reduce the cost of production, not only by the increased efficiency of the machinery used, but also by lessening the fixed charges. However excellent the method of two-rate charging may be, nevertheless the important factor in the whole plan is the consumer.

Looking at the question entirely from the consumer's standpoint, which, after all, must be the final outlook, it is found that the system of charging at different rates for current is a very unsatisfactory way of selling it for many reasons, among the most prominent being the fact that it is entirely unfeasible to educate the average consumer up to the theory of two-rate charging. In a city with a mixed populatoin of all nations it is impossible to explain two-rate charging to the ignorant classes.

The selling of current may be compared to the selling of any other commodity, in that nearly every business has what we might call a load curve and hours of most profitable selling. The adjustment is not made, however, in commercial circles by selling goods at one price during certain hours and at a cheaper rate during others. The manifest absurdity of such a course appears evident in the case of a dry goods store, or similar house, and why is it not equally absurd in the selling of current? We find in all commercial business the price regulated by the amount bought. If goods are purchased in large quantities certain discounts are secured; if purchased in small amounts the buyer has to pay

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more. This, then, being the usual method throughout the world, why should electricity be made a singular exception to the universal law of demand and price? A business house operated upon the system of two-rate charging would be laughed at, yet it costs more for them to sell goods with an empty store than with a crowded one, because the quota of clerks necessary to wait upon the people during the busy hours has to be maintained during the hours of small business. The analogy between the central station and the usual business house is clearly a suitable one, in that the fixed charges, load curve and demand in each case show a great similarity.

What the consumer wants is current at the lowest price obtainable, and John Smith is not satisfied unless he gets it at the same price that Paul Jones does. The hours during which he uses the current he considers, and rightly too, a matter entirely regulated by his own wishes, and does not understand why he should help pay for the current which Paul Jones uses because the business of the latter necessitates the use of current at a different time of the day.

This attitude of the consumer makes difficult any system of two-rate charging. A sliding scale of discounts is readily accepted, as the consumer is entirely familiar with this method of buying, and can understand it perfectly. A fixed price per kilowatt and a fixed discount according to the amount consumed seems eventually the system which must be adopted as being the simplest and most satisfactory.

The income from a certain amount of current produced can be made the same, whether charged for according to the demand or at a fixed rate, and certainly the rate which satisfies the consumer is the one that should be adopted. It is advocated that the central station should discourage the use of current at the time of the peak and try to cut it down. As a well-known fact, the consumer will not burn light in the daytime unless he needs it, no matter what the rate may be. His need at the time of the peak is just as great as if he had not used light all day, and in that case, if the rate is high at this time of day, he will use some other method of lighting. If the central station discourages the use of light at the time of the peak by charging at a higher rate, they simply lose a profitable portion of their load.

It is our opinion that every known means should be employed to encourage the use of light at all periods of the twenty-four hours and adjust the matter of the peak in the plant itself, or by means of sub-station storage batteries. If John Smith wishes to burn his lights only for two hours in the evening, by all means encourage him to do so, as otherwise he might not use light at all, and thus the central station would lose that amount of custom. It sifts itself down to the simple question of whether a peak load pays, and under what conditions it pays best.

The question seems to be readily solved by the use of accumulators. The peak is being stored during the period of light load—true at a loss in efficiency of transformation, but at a time when it would load up a unit which might otherwise be working at half load, and therefore at low efficiency. It is therefore evident that the question of an even load line must eventually, from the very nature of the case, be answered by some means in the plant itself, and not by a system of two-rate charging.

A plant operated so that the engine output is always a straight line would have no difficulty in quickly ascertaining the lowest figure at which it could sell current with a fair profit. It would then be a matter of indifference at what hour the peak of the load obtained. The consumer could be approached and told that current costs so much, and that a sliding scale of discounts is given, according to the amount he consumes. The matter then becomes very simple. The consumer is satisfied, because all parties are getting current at the same price, and hence no jealousy is felt. Where different rates have been fixed it eventually leaks around that so and so gets current cheaper than some one else, and then a vigorous complaint is made. The company, in order to retain the consumer, has to concede the lower rate to him. These complications and an unnecessary amount of clerical labor can be avoided by having a fixed price.

The load line of the consumer, as a general rule, usually corresponds in a measure with the load line of the plant, and it is perfectly equitable from the standpoint of the central station to encourage by cheap rates day and all-night burning. The method in itself is just, and if it could be carried out in minutest detail, with all the consumers working in harmony, no better way could be found of selling current. But the consumers will not work in harmony. One man will not consent to be charged at a higher rate than his neighbor if he can possibly help himself, and so the whole problem is thrown off the consumer's shoulders and left for the central station to solve.

Everything points to a solution by accumulation for doing away with the excessive engine peak at certain hours.

In conclusion, I would add, from the standpoint of the consumer, a fixed price per kilowatt, with a sliding scale of discounts, is what is wanted as being the most equitable basis of charging. The central station can receive the same income from the same quantity of current sold without prejudice or favor, and be at all times on a harmonious footing with its consumers.

[The above article was received too late for insertion in its proper position, ahead of the editorial pages.—Ed.]

## Artificial Graphite

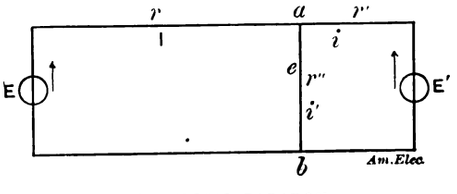
It is proposed to manufacture graphite by electrical means, and a factory will be erected for this purpose at Niagara Falls in the spring. Mr. Edward G. Acheson is the inventor of the process, which will also be applied in the manufacture of electric light carbons, converting the ordinary carbon partly into graphite, thereby improving the conductivity and hardness.

# Letters on Practical Subjects

## An Electrical Paradox.

Owing to an unexpected rush at the time of going to press with our last issue, Fig. 1, which we publish herewith, of Mr. Baxter's communication, was left out, and the other figures were numbered 1, 2 and 3, whereas they should have been 2, 3 and 4. Several typographical errors were allowed to slip through which are rectified in the following:

In equation (2) the numerator of the second member should be E — r I. In equa-




AN ELECTRICAL PARADOX.

tion (4), the first member is—i. The equation at the end of third paragraph on page 93, should be

$$r\,I = \frac{(2r'' + r')\,E}{2r'' + r'} = E.$$

and the line following it should read:

"Hence, since r I = E, and e = E—r I, we have—e = o."

## Wastefulness of Live Steam Injectors.

*To the Editor of American Electrician:*

Sir—Mr. Hobart, in his letter in your January issue, does not meet my point as to the wastefulness of a live steam injector. The experiment which he describes will, of course, result exactly as he states. In my letter I say, "with the injector and return trap, the heat units in the steam consumed are absorbed by the water, and so returned to the boiler, the water being heated in passing through the apparatus." So far we are at one. My point is, that this rise in temperature prevents the absorption from exhaust steam of just that many heat units per pound of water, and, since these latter would be obtained without expense of fuel, the heat absorbed in the injector from live steam is wasted, although returned to the boiler. In other words, this heat, an expensive product of the boiler, is substituted for heat from exhaust steam, a waste product of the engine.

I think that Mr. Hobart will agree, first, that over and above the work of forcing the water, no part of the heat in the steam used in the injector is really recovered, unless the temperature of the feed entering the boiler is raised; second, that with a proper equipment of exhaust steam feed water heaters, the temperature of the feed entering the boiler will be the same, whether a pump or an injector be used.

The necessary corollary from these two

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propositions is, that if a plant be properly equipped with exhaust steam heaters, the heat of the live steam used by the injector is recovered only to the amount of the actual work of forcing the water, and the remainder is lost.

JOHN WILSON BROWN, JR.

Philadelphia, Pa.

### A Mild Puzzle.

*To the Editor of American Electrician:*

Sir—Having read with much interest in the February number of the AMERICAN ELECTRICIAN, Mr. J. C. Brown's "Mild Puzzle," I offer what seems to me to be a reasonable explanation.

When the machine is connected as shown in Fig. 2, its field armature and the voltmeter offer parallel paths for current from the 110-volt mains, a, b. The parallel connection enables more current to be taken, and consequently the motor was dragged ahead of its normal speed.

The 115-volts indicated by the voltmeter was caused by the counter e.m.f. of the armature acting as a booster to the current of the mains, increasing the pressure from 110 to 115 volts.

In Fig. 3, as soon as the mains a, b, were cut, the armature sent a current around the field magnets in opposition to the direction of the previous current from the mains, a, b. In reversing the polarity of the magnets, the existing lines of force had first to be destroyed, and other lines of force set up in the opposite direction.

As the e.m.f. in the armature is dependent upon the lines of force through which the coils pass, as soon as the existing lines of force were destroyed preparatory to setting up lines of force in the opposite direction, the cause of the e.m.f. was removed and, of course, the current stopped, as the experiment proved. In other words, the magnets demagnetized themselves. The condition of the machine in Fig. 3 was similar to a new dynamo when it is run for the first time. A few lines of force sent through its magnets would cause it to build up and run as a shunt dynamo.

R. L. JOHNSTON.

Bangor, Maine.

### Obtaining Constant Motor Speed.

*To the Editor of American Electrician:*

Sir—I wish to give your readers the benefit of a little bit of experience that I've had recently, and select this means of doing so. My job was to get a No. 3 Westinghouse motor belted to a wheel grinder so as to give an emery wheel peripheral speed of about 5000 feet per minute. Without entering into a consideration of the counter belting, suffice it to say this emery wheel speed called for an armature speed of 1000 r.p.m. The motor was first connected up as an ordinary street railway series motor, and resistance coils put in circuit till the required armature speed was obtained. Upon trying the speed next day, under apparently similar conditions, it was found to be 200 revolutions too high. The motor was run from a feeder subject to considerable variation in voltage, but not enough to warrant so marked a difference in speed. It was noticed that the motor pulley grew very warm, evidencing slipping of the belt. The day upon which the first test was made was a cold day, the day of the second test a warm one; the belt was new. It was therefore concluded that there was more slipping on the warm day, and a subsequent trial proved this to be so. It was then decided to make the armature speed, in a measure, independent of the very light load which the armature was called upon to carry by separately exciting its field magnets. By means of half a dozen coils taken from an old street-car heater the field current was made 8 amps., at which speed the armature ran at exactly 1100 r.p.m. There was no perceptible difference in the speed whether the belt was on or off, and the speed under similar conditions has been found to be the same every day since, except for minor variations due to variations of voltage, governed by the time of day at which the tests were made.

The solution of the problem finds itself in the fact that on a constant potential circuit a series connected motor is inferior to a shunt connected motor, and also to a separately excited motor, as regards speed regulation. The connections adopted above are those of a shunt motor, and both field and armature are subject to variations of voltage, but the effect on the two are opposite even if not equal; a reduction in line voltage reduces the pressure applied to the armature, thereby reducing its speed, while, on the other hand, the same reduction in voltage weakens the field and tends to increase the speed. How far these tendencies neutralize each other the writer does not know. Armature speeds on shunt and separately excited motors are less influenced by variations in mechanical load, because the field circuits are independent, and as long as the voltage is constant the fields are constant, and therefore do not enter as a factor of variation in the speed. On a series motor, since field and armature are in series, any change which influences one influences the other, thereby multiplying the effect. S. T. DORMAN.

New York.

### An Electrical Paradox.

*To the Editor of American Electrician:*

Sir—In connection with Mr. Laird's second paradox, it is stated that there is no decomposition when an electric current forms a closed circuit within an electrolyte. May there not be decomposition and recomposition simultaneously? When two electrodes are placed in water we know that if a current passes between them, two atoms of hydrogen will appear on one plate for each atom of oxygen at the other. But if the two atoms of hydrogen and one of oxygen should meet before they had taken on the state of independent molecules, and the influence which separated them were reversed, would they not reunite to form water?

Is it necessary that the separated atoms of hydrogen and oxygen be formed into molecules of hydrogen and oxygen before decomposition can be said to have taken place? In other words, will not the electrolyte be decomposed and recomposed according to the Grotthus hypothesis, even though there is no external evidence of such action? AVA R. COLEMAN.

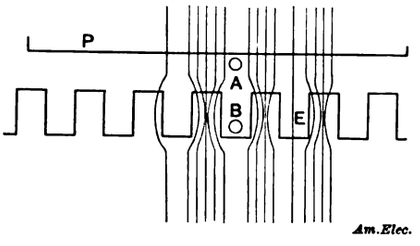
Homer, Ky.

### Why There is no Pull on an Armature Conductor in a Slot.

*To the Editor of American Electrician:*

Sir—The accompanying explanation may assist some of your readers in understanding why there is no pull on an armature conductor in a slot.

In the accompanying diagram, A is a conductor in the air gap, as on a smooth core armature, and B is a conductor in a slot on an iron-clad armature. Now in a given time A and B would cut the same number of lines of force and hence generate




FLUX FROM POLE TO ARMATURE.

the same e.m.f. But while the *rate* of cutting will be the same for A and B, the *velocity* at which B cuts will be much greater than the velocity at which A cuts. That is, we may suppose a line of force to remain in a tooth until the reluctance of its path becomes greater than the reluctance of the path to the bottom of its slot, shown at E, when it will quickly sweep over the slot to the next tooth. If A and B carry the same current, equal work is done in making either cut a line of force, and since they both cut a line in the same interval of time, the rates of work are equal. But since B meets its resistance with a much higher relative velocity than A, the force required to propel it will be much less.

We may look at the matter in another way. The force on a conductor carrying a current depends on the density of the field in which it lies. Obviously A lies in a much denser field than B and will be subjected to a greater force. The force on B will become appreciable only when the magnetization of the teeth is pushed beyond saturation, and some of the lines are forced to remain in the long air gap to the bottoms of the slots. R. K. WRIGHT.

San Francisco, Cal.

### Reducing Speed of Motors.

*To the Editor of American Electrician:*

Sir—It may interest some of your many readers to hear about what was, to me, a

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very ingenious method of reducing the speed on a multipolar motor used in driving the shafting of a street railway repair shop. The motor in question was a four-pole, compound-wound Thomson-Houston 100-h.p. street railway generator, ring-wound and provided with four brushes cross-connected by means of two copper half-circles. To reduce the speed two brushes had been removed and the remaining two placed diametrically opposite, just

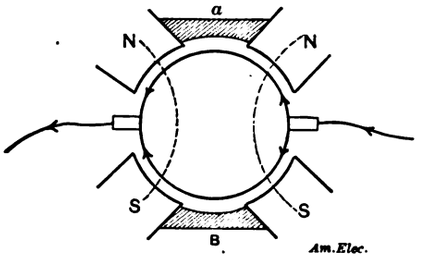



FIG. 1.—SHOWING PATH OF LINES OF FORCE IN DYNAMO FIELD.

as they would be on a regular bipolar machine. This machine had, in fact, been converted into a bipolar machine, and as follows:

The fields were so connected that there were two norths above and two souths below, instead of alternate north and south as is usually the case. The result of this was to have the magnetic lines of force run as shown in Fig. 1, instead of taking the usual path shown in Fig. 2. To improve the effect of the compound poles N N and S S blocks of iron were placed at a b, thereby lessening the leakage from N to S, and more evenly distributing the work among the armature wires. These two norths and two souths virtually amount to the same thing as one big north and one big south, so the machine is in reality a bipolar, with neutral points on the right and left and calling for brushes at c and d.

That the machine ran at much reduced speed is due to the fact that with the bipolar field connection and only two brushes there were more active armature conductors in series. In Fig. 2 we have four brushes, and we see that the circuit splits

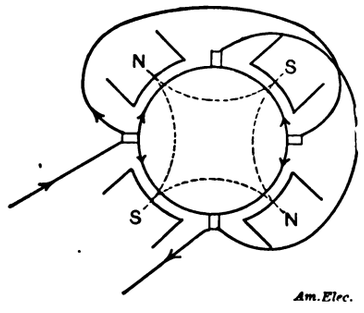



FIG. 2.—SHOWING PATH OF LINES OF FORCE IN DYNAMO FIELD.

twice, and that only the armature wires included between any two brushes are in series. In Fig. 1 the distance between brushes has been doubled, hence also the number of armature wires in series. In other words, the counter e.m.f. has been increased, the machine can take less current at a given voltage, and therefore must run slower for a given mechanical load. The fact must not be overlooked that the effect of dispensing with one set of brushes has been to halve the capacity of the machine; because when we make a two-circuited armature out of a four-circuited one it cuts the current capacity down one-half, and since the voltage remains the same, and since the output is the product of voltage and current, the input is halved.

To restore the machine to its normal capacity it would be necessary to double the impressed voltage, thereby raising the speed to its rated value. I find in this particular case, however, there was no liability to danger, as the machine was far too large for the amount of work assigned to it. It is not, perhaps, out of place to add that the man who devised this scheme does his own cast-welding, builds his own cars and trucks (of late), creosotes his own ties, does his own foundry work, builds home-made air brakes (and they work), and blows snow and bricks off the track with a home-made motor-driven air blast.

R. L. MASON.

Brooklyn, N. Y.

## A Simple Apparatus for Converting Battery Current into Polyphase Currents.

*To the Editor of American Electrician:*

Sir—I notice in the "Queries and Answers" column of the January number the question signed A. O. D. N., "How can the rotary field be simply illustrated?"

Having lately constructed a small piece of apparatus for converting battery current into two-phase alternating, for the purpose of illustrating the rotary magnetic field, and, thinking that perhaps "A. O. D. N.," or others of your readers would be interested, I send a rough sketch, showing connections, and a photograph showing the apparatus as completed, and also an experimental form of a two-phase induction motor.

The diagram shows a modified form of apparatus in order to make connections clear. A and $A_1$ represent two brass circles mounted upon an insulating disc. B, B and $B_1$ $B_1$ represent four brass segments, insulated from each other.

One outer segment is connected to the inner circle, and the other segment to outer circle.

The two inner segments are connected likewise, one to inner and one to outer circle.

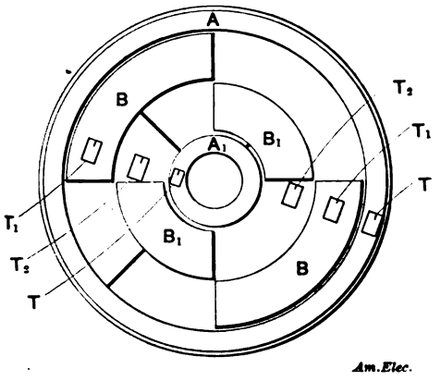



FIG. 1.—DIAGRAM SHOWING CONNECTIONS OF CONVERTING APPARATUS.

By providing brushes, as shown, and connecting battery with TT, and then rotating the discs, currents which will produce a rotary magnetic field in a two-phase winding may be taken from the points $T_1$ $T_1$ and $T_2$ $T_2$.

While this does not produce true alternating currents, which rise and fall gradually, it will, nevertheless, cause the rotar of a toy two-phase induction motor to revolve rapidly. It also has the advantage of using no liquid.

CHAS. C. WAITE.

Newark, N. J.

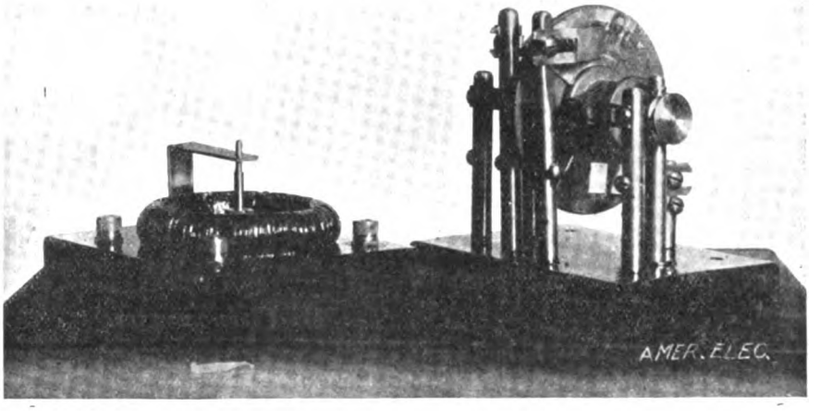



FIG. 2.—APPARATUS FOR CONVERTING BATTERY CURRENT INTO POLYPHASE CURRENTS, AND SHOWING SMALL TWO-PHASE INDUCTION MOTOR.

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### To Measure the Current Flowing in a Conductor Which May not be Cut.

*To the Editor of American Electrician:*

Sir—It is sometimes necessary to meas-pension bridge, and the following is a method whereby this may be done:

Let C D be such a conductor, say a cable of a suspension bridge. G is a sensitive galvanometer of low resistance, A is an ammeter, S a storage battery or other source of e.m.f. and r an adjustable resistance. Now, let r be adjusted until the galvanometer G shows no deflection; then the current passing over G D may be read on the ammeter A. (For proof, see letter on "Electrical Paradox" in the January issue.)

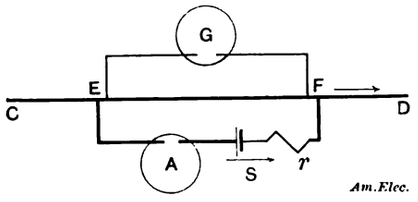



DIAGRAM OF CIRCUITS.

The condition necesary for this measurement is

$$\frac{\text{e.m.f of storage battery}}{\text{resistance of shunt circuit}} = \text{current in C D,}$$

and the current in the circuit, of which C D is a part, is changed by the amount due to the removal of the resistance of the conductor from E to F from the circuit.

St. Louis, Mo. H. L. HOLDEN.

### A Handy Rule for Magnet Windings.

*To the Editor of American Electrician:*

Sir—If we assume a current density of 1000 amps. per sq. in., the carrying capacity of a circular mil is 0.0007855 amps. The resistance of a mil-foot of copper wire at 75 deg. F. is 10.51 ohms. Hence, if E is the voltage of the circuit to which the winding is to be attached

$$0.0007855 = \frac{E}{L \times 10.51} \text{ or } L = 121 \times E$$

where L is the length of the magnet wire in feet. If the estimated length of a mean turn about the magnet core is t, the number of turns will be $\frac{L}{t} = N$; and if the necessary number of amp. turns is M, the current the wire must carry will be $\frac{M}{N}$. The circular mils necessary to carry one amp. at 1000 amps. per sq. in. are 1273; therefore, the cross section of the wire in circular mils is $1273 \frac{M}{N} = 10.5 \frac{Mt}{E}$, and the number of the wire may easily be found in the tables. These formulæ, length of wire = 121 E ft. and size of wire = $10.5 \frac{Mt}{E}$ mils, are much more convenient to apply than the formulæ usually given.

GEO. H. GIBSON.

Ann Arbor, Mich.

## Electrical Catechism

*275. Are all electrical measuring instruments based upon the electro-dynamic or the electro-magnetic effects of the current?*

By far the greater number of them are, but other effects have been used, such as the electro-chemical, the heating and the electro-static effects.

*276. What is the electro-chemical effect as used for measuring current?*

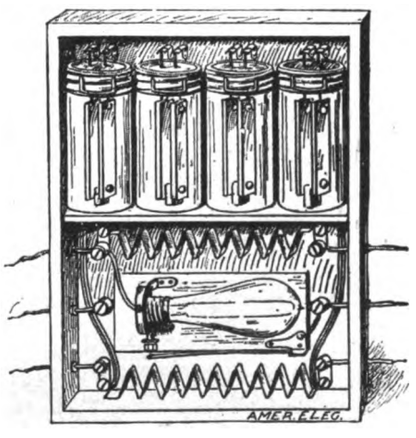
When current passes through any liquid conductor (unless it be an elementary substance, such as mercury) the liquid is decomposed, part going to the "anode," the conductor where the current enters the liquid, and part going to the "cathode," where the current leaves the liquid. The anode is dissolved to some extent. When used for measuring, it is customary to have as the liquid a solution of some salt of the same metal that is used for the anode. In the standard form, pure silver is used for the anode, a solution of nitrate of silver for the electrolyte (the liquid) and a platinum bowl for the cathode. A current of 1 amp. deposits 0.001118 gram of silver per second upon the cathode. Such an apparatus is called a voltmeter.

*277. Is the voltameter an accurate instrument?*

It is in the hands of skilled operators. In fact, the voltameter has been adopted by the British and by the United States governments as the standard means for calibrating instruments for measuring currents.

*278. Is the voltameter used as a commercial instrument?*

It has been developed by the Edison Company and was used by them quite extensively for measuring the amount of current used by customers. The meter consists of a German silver "shunt," which carries nearly all of the current and one or two voltameter connected in multiple with it. The resistance of the shunt and of the voltameter are so adjusted that 1/975th part of the current passes through the voltameter, which consists of a bottle containing two zinc plates in a solution of zinc sulphate. The zinc is dissolved at the anode and deposited upon the cathode at the rate of 1224 milligrams for one ampere-hour. The plates are carefully weighed at the beginning and end of each month, the loss in the weight of the anode divided by 1224 and multiplied by 975 shows the number of ampere-hours of current that have passed through the meter. Two voltameters are used, so that one will check the other. For use on three-wire systems the meter is double, there being a shunt and voltameter on each outside wire, none being needed on the neutral wire. In the early meters 1/1000th part of the current passed through the voltameter.




EDISON METER.

*279. Does the chemical meter measure the watt-hours used by a consumer?*

No. It measures the ampere-hours only. But the voltage is supposed to be kept constant, so that the ampere-hours should bear a definite ratio to the watt-hours.

*280. Can the voltameter be used as a voltmeter for measuring pressure?*

Not in its ordinary form. It has been proposed to make one with a very high resistance, in which case the current would be proportional to the pressure. The change of weight of the electrodes might then be taken to determine the average pressure. This has not been very successful.

*281. Can the voltameter be used as an ammeter?*

Not directly. The change of weight during a given time measures the average current during that time, so that it may be considered as an ammeter when the current remains constant. It is not convenient for such purposes and is only used for scientific tests.

*282. Is the voltameter suitable for use as a meter for alternating currents?*

No. Since the alternating current goes first in one direction and then in the other, whatever effect might be produced by one alternation would be reversed by the next, except that in voltameters in which gases are produced, some of the gas might escape between reversals.

*283. How can the heating effect of the current be used for measurement?*

Since every conductor has more or less resistance, it causes a drop in pressure of any current passing, the drop being equal to the product of current by the resistance. This involves the absorption of energy equal to the product of current by drops. The energy thus absorbed appears as heat, which raises the temperature of the conductor. The amount of heat developed in a given time may be measured by an instrument called a calorimeter, from which the current may be calculated if it has been constant. This method was a favorite one when alternating currents first came into use, but it is inconvenient and is rarely used at present.

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# Queries and Answers

How may the carbons and the porous cups of sal ammoniac batteries be renewed? D. H.

Boil them in water.

I have built a small dynamo, which will not work. I can see no fault in the construction, only the armature is not exactly round and the field magnets at one place are nearly one-half inch from the armature. Can you tell me what is the matter? L. D. N.

Your question is answered in the second sentence of your query.

How much current from a 110-volt circuit, and what size of wire, are required for a medium electric soldering iron? L. P.

Two amperes of current will be required, and No. 22 iron wire or smaller.

Will there be any harm in substituting a German silver for an iron resistance in a 110-volt direct-current lamp? C. T.

Yes, but the change will not make the slightest electrical difference.

Is the watt consumption of an incandescent lamp proportional to the volts? A. T. B.

Not exactly, as the resistance decreases as the temperature of the filament rises.

How is gun powder exploded by electricity? S. F. A.

By means of a primer containing a fine wire, which is heated to incandescence by the electric current.

Is it good practice to short-circuit a high-resistance gravity line when not in use? J. F. E.

No, though it should not be kept open for long periods without an occasional discharge to keep it in condition.

One of our dynamos is a 700-light shunt machine, which runs well with a steady load, but with less than 50 amps. starts to run away. We have two 125-light compound dynamos of the same type, which run equally well at all loads. What is the matter with the large machine? W. H.

As the speed of the machine is entirely dependent upon the prime mover, the fault lies with the latter.

I have a fan motor rated at 3 amps. at 6 volts. Can I change this into a three-phase rotary converter by providing a triphase wound armature? B. L. G.

By connecting three rings to equidistant commutator bars, you will have a rotary converter that will give three-phase currents.

What solution and batteries should I use for nickel plating small articles? L. P.

A proper answer to this would require a treatise such as can be bought in book form. Besides, nickel plating is an art that requires skill.

What are the electrical properties of selenium? G. M. J.

The electrical resistance of selenium varies with the amount of light to which it is exposed, decreasing in sunlight to about one-half its resistance in the dark.

What would be the cost of a storage battery to run six 16-c.p. lamps for sixteen hours on one charge? Also, the cost of charging the same by battery and from a lighting circuit? L. E. B.

The battery would cost about $400. The cost to charge from a primary battery would be prohibitive. A central station could charge the battery for $1.00 or less.

What determines the charging voltage and amperes of a storage cell? H. C. S.

The charging capacity of a storage cell is about 2.45 volts; the charging current is from 8 to 9 amps. per sq. ft. of positive surface, including both sides of the positive plates.

How may an armature be tested for a ground? W. S.

Take the leads out of opposite commutator bars, when the ground, if single, can be easily located in one of the halves. Then proceed similarly to locate in a quarter, and so on.

I have a home-made seven-plate, four-cell storage battery, which, when charged by a gravity battery, will, when running a 3-amp. fan motor, drop from 8 to 4½ volts after ten minutes. If left idle about fifteen minutes the voltage recovers to 6½ volts. What is the matter? W. H.

The cells are not properly charged. A gravity battery will not satisfactorily charge a storage battery. Not only is the rate of charging small, but a great part of the current is wasted.

A ring armature is wound with No. 18 wire, forty-eight turns in a section, 138 sections. What would be the effect if four of the sections had only twenty-four turns? A. M.

If the four sections were close together, there might be some sparking and heating; if well distributed around the armature the only difference would be a very slight reduction in voltage at the brushes.

How is the current capacity of a machine determined? W. S. W.

Divide by the voltage, the rated capacity of the machine in watts (1000 times the kw. rating). If rated in horse-power, multiply the horse-power by 746, and divide by the voltage.

Kindly advise me what mathematical books I should study in order to thoroughly understand the various works on electrical engineering. I have studied algebra to quadratics, plane geometry and trigonometry. G. E. H.

Review the three studies mentioned, extending algebra, and you will be amply qualified, though a knowledge of elementary calculus would not be amiss. How could you study trigonometry with benefit on such a slight basis of algebra?

I want to build a dynamotor for a 110-volt circuit, to give an output of 16 volts and 1 amp. Kindly give directions. A. P. H. S.

If you already have a motor, try a third brush, making contact at an angular distance from one of the original brushes of about 30 degs. on the commutator. If the motor is not too small the small current taken should cause little or no sparking.

Why will a car go down a grade faster with the power off than with it on? J. B. C.

It will not do so. In practice, the electric power is cut off when the grade is entered, and gravity, acting on the car, may give it a greater speed than the motors possibly could, if the descent is long and steep and the car not braked.

How can I prevent the sulphuric acid from creeping up the terminals of sealed storage cells, thus loosening the cement and causing corrosion? G. J. W.

The only remedy is to make as good a juncture as possible between the cement and terminals, and to provide a small vent, but this will not insure permanent protection. The terminals may be effectually protected against corrosion by keeping them covered with vaseline.

A friend contends that there are three classes of currents—direct, continuous and alternating; while I believe there are but two—alternating and direct. Who is right? A. C.

It is correct to say there are direct, alternating, continuous, pulsatory, undulatory, oscillatory, periodic and intermittent currents, and these possibly do not exhaust the list. The aim should be to know the peculiarities of currents, and not waste effort on academic distinctions.

A Wood arc machine flashes at the commutator and scars at every twentieth bar. Is the trouble probably on the line or in the machine? B. J.

The trouble is probably in the armature. After the commutator is thoroughly sandpapered, measure the resistance between the bars at the defective places, and also at several other points, thus determining whether any portion of the armature is short-circuited or contains a poor contact.

What is the weight of positive active material necessary in a storage cell for each ampere-hour of discharge? F. E. A.

According to the chemical theory, for each ampere-hour delivered, 4.45 grams of peroxide of lead are converted into 5.65 grams of sulphate of lead; that is, about 1 lb. of peroxide per 100 amp.-hours. In practice, all the peroxide of a plate cannot be utilized, and from two to six times more than the above amount of peroxide is used.

What is the probable cause of armature sections burning out, the commutator not sparking? A. M.

Among probable causes are insufficient insulation; connecting up several coils backward; cutting out several coils or parts of coils lying within a half circumfe ence, which unbalances the two paths of the winding, causing one-half to force current through the other under conditions similar to a short circuit.

1. Can storage cells discharged to different degrees be recharged in series? 2. Could part of sixty cells be connected in multiple on a 110-volt circuit and properly charged? 3. What resistance would be required for two sets of thirty cells each in parallel, if charged from a 110-volt circuit? 4. For what capacity should a booster be wound to fit the above requirements? L. T.

1. Yes, but at a loss and with obnoxious "boiling" on the part of the cells least discharged. 2. Yes, but the cells in multiple would only take half the current of the others, which would "boil" and give off noxious gases while the charge of the former was being completed. 3. Thirty cells would take about 75 volts, and the resistance required would be, in ohms, 35 divided by the charging current. 4. Forty volts and the amperes of the charging rate.

What is the relation between the ampere turns on an electromagnet and the lines of force which pass between its poles? C. A. S.

The magnetomotive force is the ampere-turns multiplied by 1.257. The flux (or number of lines of force) is the quotient of the magnetomotive force by the reluctance of the magnetic circuit. The reluctance depends upon the dimensions of the magnetic circuit and the specific reluctance (reluctivity) of the materials entering into it. The reluctance of air is unity through 1 sq. centimeter 1 centimeter long; that of iron is what the air reluctance would be for the same section and length, divided by the permeability of the particular iron used, as found from its magnetic curve.

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## GAS ENGINES: HOW THEY ARE MADE

The industrial world is becoming more and more impressed with the value of the gas engine as a factor, both for power and for driving electric current-generating machines, and those who have not given much attention to the matter will be surprised to learn to what magnitude the industry of making this class of engines has developed in recent years. Among the manufacturers of this type of engine the White & Middleton Gas Engine Company, of Baltimore, hold a prominent place, and it is the province of this article to describe some of the particular features of this make of engine and the shop methods employed in their construction, as noted on a recent visit to the works.

The works occupy a substantial brick building, 220 ft. x 85 ft., located on Charles and Winder streets. The main floor of the building is divided lengthways into three bays, with a high monitor roof over the middle one. A traveling crane spans the middle bay, and each of the others are provided with two lines of shafting, from which, by means of belts, the machine tools are driven, so that there are no belts crossing the middle bay. The company believes in taking their own medicine, and employ two of their 25 h.p. engines for driving the shafting. These are located at the back end of the main floor, and power is transmitted to the shafting by means of them.

In this connection it may be noted that the two engines employed are of the vertical type, and gasoline is used as fuel, the supply being drawn by means of a pump from an underground tank, located in the yard some distance from the building. A pump is attached to each engine, and runs continuously, forcing the oil into a small reservoir at the end of a standpipe, at an elevation a little above the engine cylinder, from whence it flows by gravity to the spraying mechanism. The reservoir holds less than a pint, and is provided with an overflow pipe through which any surplus oil is led back to the tank, so that there is only a very small quantity at any time inside the building.

The output of the works includes both vertical and horizontal engines, rated from 1 to 65 h.p., and designed to consume either gas or gasoline. In both types of engines the cylinders are water-jacketed, and when gas is employed the charge is ignited by means of an electric spark, a small battery of two or three cells being employed for generating the current. For employing gas a chimney with the usual igniting flame replaces the sparking apparatus, and the latter will be described later on.

In each type of engine a trunk single-acting piston is employed, which serves as a crosshead with the walls of the cylinder as guides, and in the vertical engine a phosphor-bronze connecting rod is employed. In both types a forged crank shaft receives the force of the impact, and is in all cases provided with two heavy fly wheels. The governing mechanism is driven by a train of gear from the main shaft and is extremely sensitive and accurate. The valves are of the spindle type and are mounted in cases, which are inserted and bolted to the head of the cylinder. One is made a little smaller than the other, so that by removing the cap of the larger one, the second may be taken off through the same hole.

A feature that attracts the attention of a visitor is the extreme accuracy employed in fitting the different parts, especially the bearings, which for all moving parts are of phosphor-bronze, even for the crosshead pin. All the journal bearings are first planed up, then the two halves soldered together, when they are turned off to accurately fit the boxes, which are previously turned and fitted. The bearings are then broken apart, and each half is riveted to the box with countersunk copper rivets. The shaft is then mounted, and the bearings scraped until an accurate fit is had over the entire surface. In the final fitting of the piston they are ground and polished on an emery wheel, as are also the valves and some of the parts of the governing mechanism. All parts of the engine are made standard size, so that they are interchangeable, and duplicate parts can always be supplied.

Each engine is carefully tested and rated before shipment, provision being made to connect with the city gas mains for the gas engines with large meters, which measure to one-tenth of a foot, so that it is easy to determine the amount of fuel each engine consumes. There is also provision for testing with oil fuel, so that the capacity of each engine is known and recorded for future reference.

The spark-igniting mechanism for the oil fuel supply consists of a combined case of porcelain and brass, with the terminals of the moving points placed at right angles to each other, and terminating in platinum buttons, between which by a make-and-break process the spark is produced, the platinum buttons being so attached that they can be turned should the contact points be consumed by the arc.

The engines are not only designed for stationary work but also for supplying power to small launches, in which line there is a large demand, and in connection with which Tobin bronze propellor shafting and small propellors are manufactured.

The offices of the company are located on the second floor, over the front portion of the building. Both Mr. White and Mr. Middleton give attention to the affairs of the company, while Mr. G. W. Stanton is superintendent of the works.

## CARD SYSTEM OF CENTRAL STATION RECORDS.

The card system of records is rapidly displacing the cumbersome and expensive methods of former years wherever the volume of business renders it applicable. Both in saving of expense and in convenience, the advantage is so great that once adopted the user would never think of returning to old methods. By means of this system, two subscription clerks in the office of the AMERICAN ELECTRICIAN do the work that would by old methods require four or five, and in an enormously more accurate and satisfactory manner. In the advertising department the system so simplifies advertising records, that a glance through a case of cards will, in a moment, give almost any information desired.

8

| NAME | | | | |
|---|---|---|---|---|
| ADDRESS | | | | |
| WATT METER NO. | SIZE | MAKE | DATE INSTALLED | DATE CUT OFF |
| POWER | ARC | INCANDESCENT | LAMPS ADDED | REASON CUT OFF |
| MAXIMUM RECORDING METERS NO. | SIZE | DATE INSTALLED | LOCATION OF METERS | |
| | | DATE CUT OFF | | |
| REMARKS | | | | |

MADE BY LIBRARY BUREAU. CH'CAGO PATENTED MAY 28, 1907

CENTRAL STATION RECORD CARD FULL SIZE.

The operation of the various departments of an electric lighting plant demands a system of records which is elastic and will readily adapt itself to the varying growth and changes incidental to such a business, and is therefore an almost ideal case for the application of the card system.

The problem which confronts the manager of an electrical plant is how to handle the multiplicity of records necessary to the proper management of his system without duplication of labor, and consequent loss in clerical help. The card system of records as adopted by many of the larger Edison stations in this country, seems to meet the peculiar requirements of the case. In the underground, installation and contract, meter and accounting departments, are cabinets containing various colored cards, arranged alphabetically, by location, in consecutive or numeric order, as the case may be, and bearing projections or

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tabs in various sequences. This apparently complicated collation is plain and simple to the accountants who handle the records in each of these departments.

For example, one list comprises all the consumers, arranged each upon a card in alphabetic order, while the tabs in different positions automatically indicate the time of burning of the lamps used by these consumers. A similar system of cards is adapted for the classification of the power users, and in each case at least two records are thus combined on one card, and half or more labor saved. Where a consecutive numeric arrangement is desired, as in the case of meters, a clever device presents itself. This system consists of cards, such as the one illustrated herewith in facsimile, bearing tabs in ten distinctive positions, running from left to right, and designating the units. Guide cards are inserted at intervals of ten, so that the operator may run his eye down a list comprising perhaps 25,000 meters, and instantly detect any number without handling the cards, or looking from one to the other to locate the one desired.

The card system for central stations as devised by the Library Bureau, 125 Franklin Street, Chicago, is adapted for both large and small plants, and for both simple and complex system of records.

## EXHAUST STEAM HEATING.

Heating a city or village from a central station through underground pipes by steam is now so common an occurrence that no argument is needed to convince people of its feasibility, the system of the American District Steam Company being in operation in a large number of places—in many, for fifteen to twenty years past. The efficiency of the exhaust steam system has been tested under the most trying circumstances and always with the most favorable results. During the extreme cold of the second week of February of the present year, the steam companies kept their customers warm, while in some of the natural gas towns, where a steam system was also in operation, the gas people were nearly frozen out. The New York Steam Company, supplying 1500 or more customers with heat and power, kept steadily along through the extreme cold and blockade of snow and ice, while many office buildings, heated in the usual way, were compelled to suspend until the blockade could be raised.

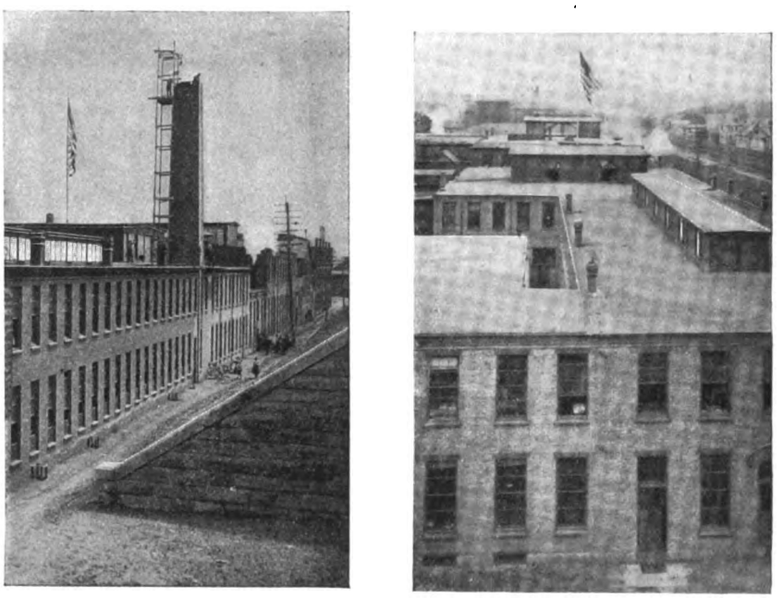
The electric light and electric railway companies are beginning to realize that they have resources which they have not properly appreciated. They have seen nine-tenths of their steam flowing from the exhaust head, regarding it as a waste product of no value. They find now that there is as much demand for heat as for light or for power, and that by piping their exhaust steam around town to heat all kinds of buildings, many thousands of dollars may be realized from the sale of this waste product. The heating fits in nicely with the other branches of the business, requiring no additional office force, and very little additional fuel.

In laying steam pipes for this purpose, as in other branches of business, it pays to do thorough work. When properly insulated and drained, tests show that in a mile of continuous pipe the loss by condensation will not be more than 1 per cent to 5 per cent, depending on the size of the pipe; while with slip-shod work where the protection is a box made of boards, the loss will be 25 per cent, as some have found to their sorrow. When there is a continuous loss of this kind the aggregate soon becomes startling. This emphasizes the necessity of thorough work whenever it is undertaken. Steam being a light fluid, it flows rapidly to its destination, requiring only the pressure generated by the boiler of the central station, hence its adaptability to use in long pipe lines.

One exhaust electric plant now in operation is heating 12,000,000 cu. ft. of space through 5600 ft. of pipe, and with the mercury 11 deg. below zero, an initial pressure at the station of only 4½ lbs. was required, no part of the pipe being larger than 12 ins.

## DRAFT WITHOUT A CHIMNEY.

Two years ago at Jamaica Plain, in the suburbs of Boston, there stood a tall chimney upon which the B. F. Sturtevant Company was entirely dependent for producing its draft for the operation of its boilers.



STURTEVANT WORKS, WITH AND WITHOUT CHIMNEY.

Changes in the arrangement of the works necessitated moving the boiler plant, but, of course, it was out of the question to take the chimney along. In its stead a fan blower was installed on top of the boilers and provided with a special engine to drive it at just the speed required. It is automatically regulated so that less than 1 lb. drop in steam pressure greatly increases the draft, starts up the fire and brings the pressure back where it belongs. It is thus kept the same hour in and hour out, and the fireman has nothing to do but shovel coal.

The fan works by suction, draws the gases from the boiler flue and forces them out through a short stack extending only 31 ft. above the boiler room floor. The draft which may be produced is two or three times stronger than that of the chimney which has been discarded. The weather makes no difference, the draft is just as strong on damp and muggy days as on those that are crisp and bright.

Though it barely extends above the roof of the surrounding buildings, no trouble whatever is experienced from smoke, for the simple reason that when draft is produced in this way, no smoke is made. The utter uselessness of the old chimney has been so clearly demonstrated that it has just been taken down for the sake of the bricks it contained. There is thus presented the novel sight of a large manufacturing plant covering a half a dozen acres with no apparent means of producing the draft; the little steel plate stack being visible only from certain points.

The cost of the entire mechanical draft equipment including the stack was less than one-half that of a new chimney, because of the stronger draft much cheaper fuel is burned than was possible with the chimney, the saving being nearly a thousand dollars a year. In another boiler plant of 1000-h.p., the full saving is $6,500 per year. At the same time the amount of steam generated may in either case be readily increased to double that for which the boilers are rated. In other words, it is possible with mechanical draft to use much smaller boilers and still produce the required amount of steam.

The fan can be built of any size and exactly adapted to any location and regulated to suit the requirements. No heavy foundations are required, it seldom requires valuable floor space, and being portable need not remain, like the chimney, a monument of departed industry.

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# New Apparatus and Appliances

## INCANDESCENT LAMP PHOTOMETER.

The accompanying illustrations show a modification of the Queen Standard Photometer as made especially for incandescent lamp photometers, in which but a small amount of time can be placed individually on the lamps in testing them, yet great accuracy is required.

Fig. 1. shows the complete instrument. At the left is a pedestal of iron carrying a stage, screen and curtain, and supporting one end of the photometer bar. An adjustable lamp support on the stage holds a secondary standard, a 16-c.p. incandescent lamp. This is standardized by comparison with a pair of certified lamps furnished with the photometer.

The pedestal on the right supports the other end of the photometer bar and carries a screen and an automatic rotating socket. The photometer bar carries a metal scale graduated in inverse squares and having the 16-point centrally located. By this arrangement the photometer reads directly in candles when using a 16-c.p. standard. The scale is inclined from the vertical so as to be illuminated by the test lamp and render the graduations legible.

The photometer carriage illustrated has a screen of the Lummer-Brodhun type, an optical screen of great accuracy. When so desired either a Bunsen or Leeson screen may be substituted.

The two rheostats below the photometer bar are for controlling the potential on the standard and tests lamps respectively. They have each about 900 steps and permit of so small a variation of the c.p. or potential as to be imperceptible on the most sensitive voltmeter.

The rotating socket supported by the right pedestal is more clearly shown in Fig. 2. The main driving shaft, A, is hollow and journaled in a step, U. It has attached to it a pulley, D, driven from some power shaft and a friction driving pulley, B. This shaft runs at 180 r.p m. Within this shaft is a central one, E, carrying a plate, C, and the screen, F. Upon the plate, C, are mounted two rotating sockets, G, H. They have journals swung from centers at X, and adjustable boxes at the bottom. Spring plugs keep a suitable pressure between the friction pulleys, B, I, and I. Collecting rings and brushes carry the current to the lamp.

At J, is a lever which engages in the plate, C, preventing it from moving. Under this condition, the main shaft, A, which is continuously rotating, will cause both lamps to revolve about their own axes at 180 r.p.m. If, however, the lever, J, is momentarily released, the lamps will revolve about the axis of the main shaft and one replace the other.

At K, is a release which attaches to a pedal below. Depressing this throws over the shaft of the rotating socket which happens to be there, releasing the pulley, I, from the driving pulley, and at the same time stopping the lamp.

The operation is as follows: When the operator at the photometer has tested the lamp, Y, the operator at the socket trips the lever, J, and the lamps exchange places. In so doing they exchange brushes, and, therefore, circuits. This construction is to permit of having lamp at Y, on normal voltage and lamp at Z, on low voltage. By this arrangement the operator in adjusting lamp at Z, is not annoyed by a strong light. After exchanging the lamps, the operator depresses pedal and by means of the release, K, stops lamp Z. It is then removed and another substituted. Releasing the pedal starts the lamp rotating slowly or fast as may be desired. If not running truly, it may be pressed to one side and it will stay where it is placed. This is accomplished by using a special socket, N. It is adapted to take lamps without base and has fluted contacts to secure a proper adjustment of the lamp terminals. When the lamp runs truly, the lever, J, may be tripped, exchanging the positions of the two lamps as before.

It will be seen that the apparatus, of which Queen & Co., 1010 Chestnut Street, Philadelphia, are the manufacturers, is well made, serviceable and quite automatic, enabling lamps to be tested with great accuracy and facility.

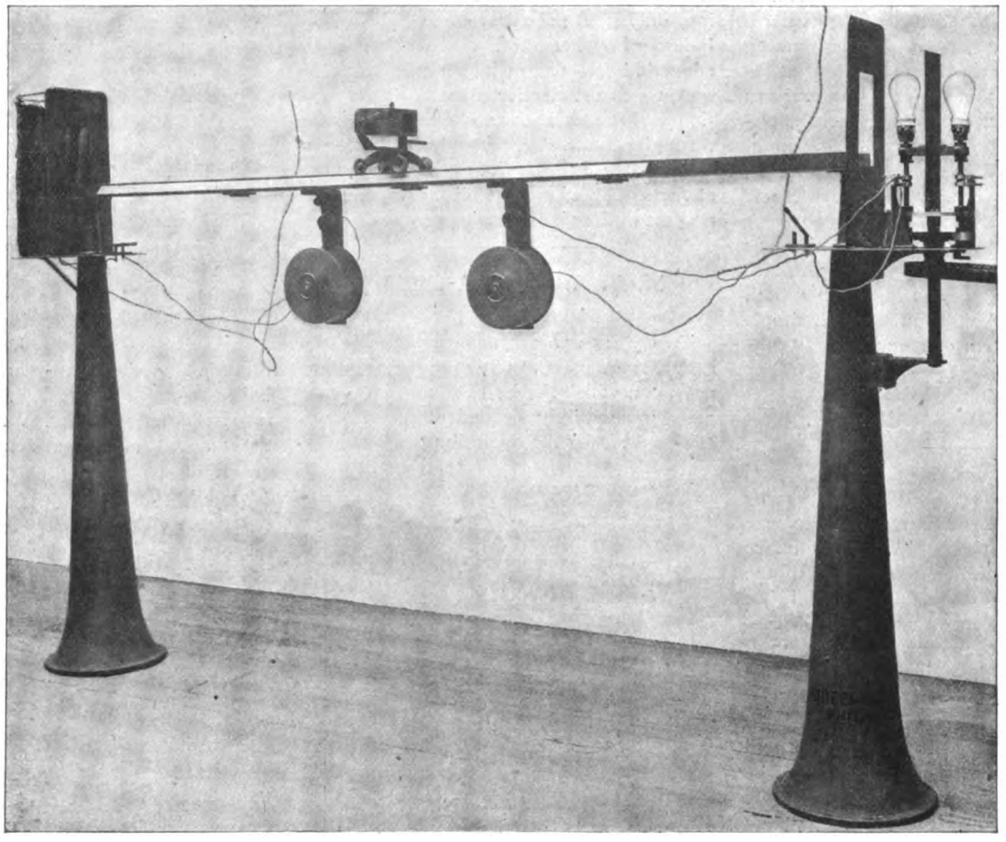


FIG. 1.—INCANDESCENT LAMP PHOTOMETER.

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TELEPHONE MAGNETO BELLS.

The magneto bell illustrated herewith is intended especially for telephone service, both local and long-distance. In the construction of the generator a departure will be noted in the manner of securing the permanent magnets to the field. Usually this is done by bolting through from one side to another, and if the bolts are tightened up sufficiently to keep magnets in place during transit, they are liable to spring the field, thus causing the armature to bind. In this case the magnets are held by short bolts which enter into projections in the field pieces, and can therefore be firmly secured without danger of any springing resulting.

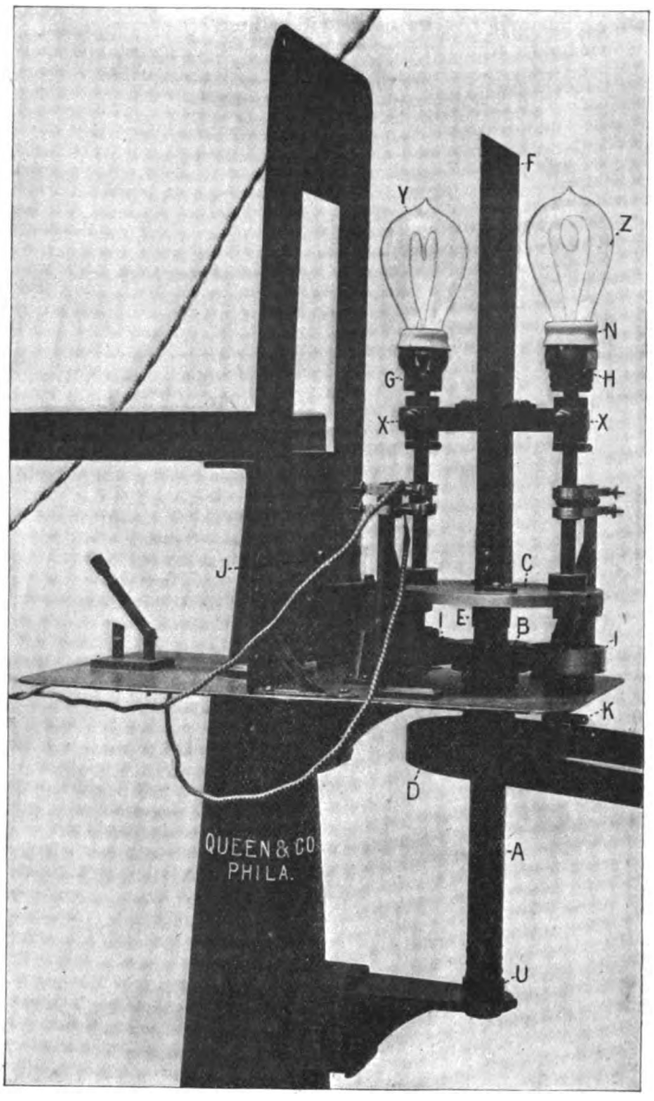



FIG. 2.—INCANDESCENT LAMP PHOTOMETER.

The generators are equipped with gears or chain and sprocket, the former being the method illustrated. The gears are finely cut, have an extra wide face and are practically noiseless in operation. The flexible method shown in the illustration for attaching the pinion to the shaft, assures a steady and uniform movement of the armature while passing through the varying magnetic field.

The armature is made of soft laminated iron, assembled on a steel shaft, accurately fitted and thoroughly insulated. Nearly twice the output is secured by this kind of armature over the usual cast-iron form.

As the shunt depends for its operation on natural forces only, there are no springs to get out of order, and it is reliable under all conditions. The slightest movement of the armature opens the circuit immediately, yet a circuit of practically no resistance is positively established whenever the armature comes to rest. The granules are silver plated, which insures always a reliable contact. The case is hermetically sealed, which effectually prevents any oil or dirt reaching the contacts. The illustration shows the shunt as it appears, both open and closed.

The method of supporting the armature

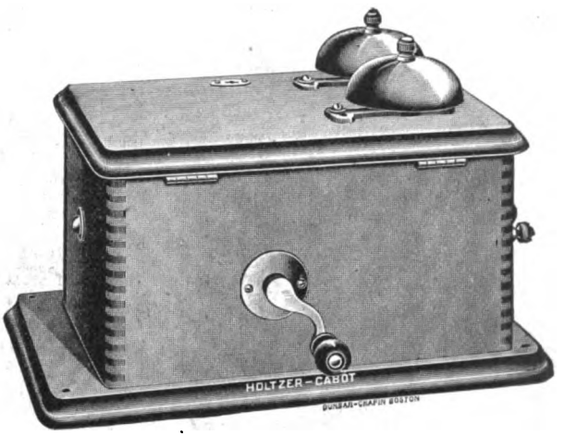



FIG. 1.—TELEPHONE MAGNETO BELL.

and at the same time holding the few parts rigidly in proper relation to one another, the facility with which such adjustment can be accurately made, simply by turning one screw, which raises or lowers the yoke carrying the armature, will commend the striker used to telephone men generally. It will be observed that the armature is always maintained centrally over the pole pieces, and in the best possible relation to them as well as to the permanent magnetic field.

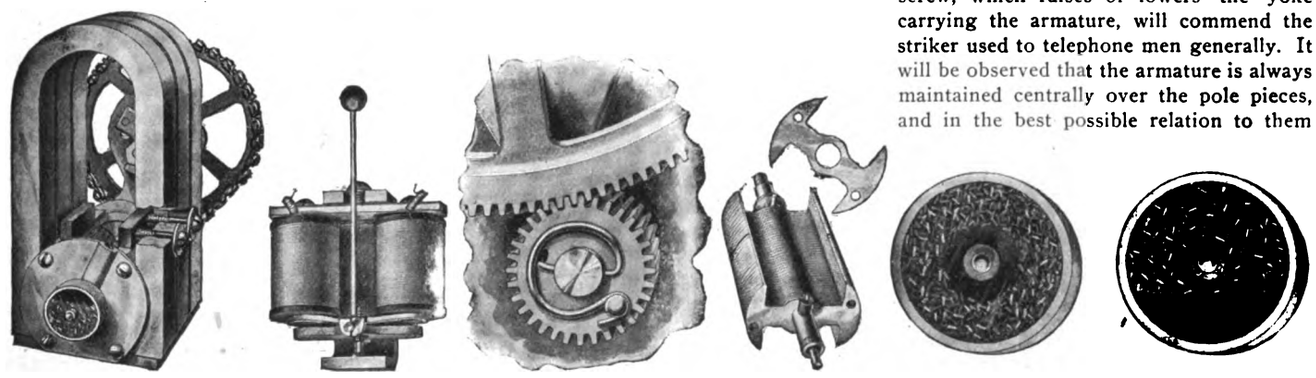


FIG. 2.—DETAILS OF TELEPHONE MAGNETO BELL.

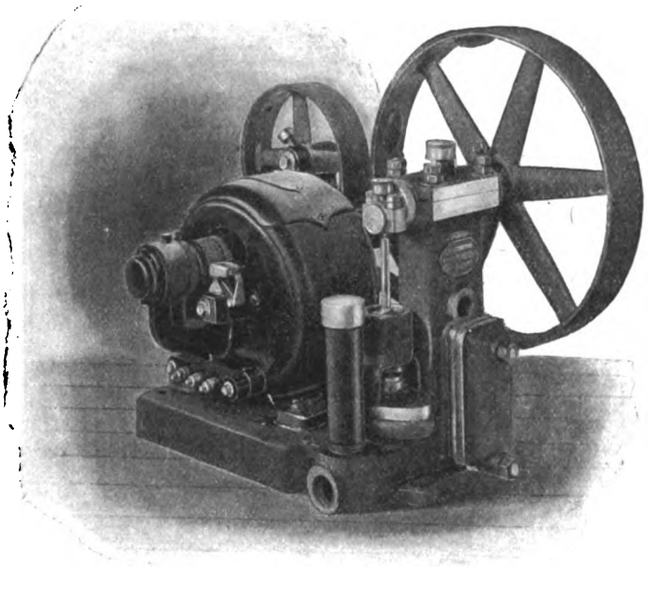
The method used of hardening and tempering the permanent magnets, which are made of a special grade of magnet steel,

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gives them the greatest possible degree of magnetic saturation. Each magnet is carefully tested and has to lift a standard soft iron bar before being passed. The manufacturers are the Holtzer-Cabot Electric Company, Brookline, Mass.

### ELECTRIC PUMPING.

A neat and compact pumping outfit for house tank and similar service is shown in the accompanying cut, being a Worthington pump direct-connected to a General Electric motor. The pump is of a type which is in use for a great variety of purposes, but is especially designed to supply the reservoir tanks of high office buildings and residences, where the pressure carried in the city mains, insufficient to elevate water above the lower stories, must be reinforced by pump pressure. The motor is connected to the pump entirely by belt, and



ELECTRICALLY DRIVEN PUMP.

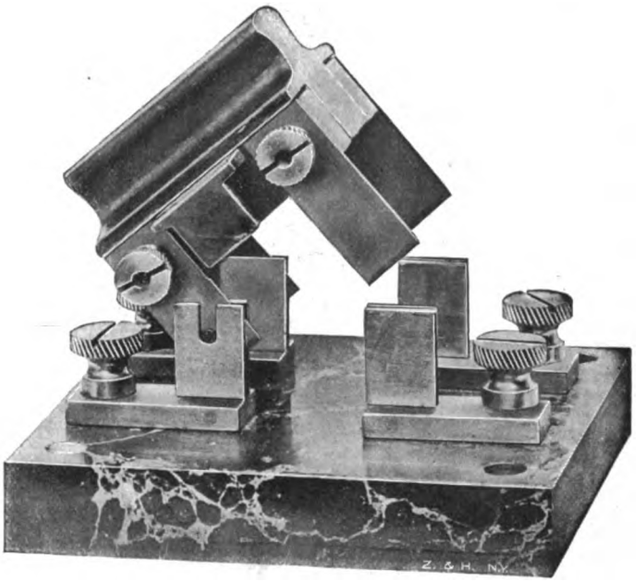
as no cut gears intervene, its operation is noiseless.

The motor is of the C. A. type—a type designed and manufactured by the General Electric Company to meet a demand for motors adapted to the direct application of power to small machines. It is built in capacities of 2 h.p., 1 h.p., ½-h.p. and ⅛-h.p. The first three are wound for use on 115, 230 and 500-volt circuits, and the ⅛-h.p. being wound for 115 volts only. They are light and compact and occupy very little floor space, while they may by a single change in the position of the bearings, be run in any position. The magnetic circuit is of laminated instead of cast iron; the armature and toothed laminations with coils made up and insulated before application. The motor is mounted upon the base of the pump, making the combination one of the most compact on the market. The motor is stopped and started by an automatic switch operated by a float on the water in the tank. These pump combinations are built for capacities of 200 and 500 gals. as required.

### REMOVABLE FUSE HOLDER.

We illustrate herewith a little device in the shape of a removable fuse holder, which is coming into favor with engineers, architects and contractors. As its name implies, it is a fuse holder which can be removed at pleasure from the circuit. In fact, in connection with suitable clips, it constitutes a switch in which the fuse connections are made on the movable part. As will be seen from the illustration, the fuse is attached directly to the switch blades, and thus does away with the necessity of having separate fuse connections provided on the clip blocks.

The two blades at one end are provided with pins which fit into appropriate slots in the clips, and when so arranged the fuse holder can be operated in the same manner as an ordinary knife switch When the fuse melts from any cause the fuse holder can be lifted out and taken away to be re-



REMOVABLE FUSE-HOLDER.

fused at any convenient place. Or, as the fuse holders are interchangeable, a previously fused holder can be substituted.

Guards are located over the fuse, and prevent the fused metal from reaching the hand should the fuse blow while the holder is being inserted on a bad circuit. These guards also prevent the fused metal from dropping on other fuses and blowing them, as sometimes happens in panel-board work, where a precaution of this kind is not taken. While this fuse holder is primarily intended for use on panel boards, it can also be used for any other purpose that a knife switch is ordinarily used for.

The manufacturers are Zimdars & Hunt, 127 Fifth Avenue, New York.

### WATER-TUBE BOILER CLEANER AND FLEXIBLE SHAFT.

The tube cleaner shown herewith is for removing scale from the tubes of boilers of the water-tube type, the use of which type is so largely increasing in central and power stations.

The cleaning device consists of a conical shaped head, having a taper of about ¾ in., and composed of discs with pivoted arms between each pair. At their outer extremities these arms carry tooth cutters about 1⅛ ins. in diameter, and these arms with their cutter discs are set spirally in the head. A series of guide bars placed on the shaft back of the head not only serve to guide the tool in the tube, but provide bearings in which the operating shaft revolves.

In the process of cleaning, the cone, which is somewhat smaller than the tube, is inserted and given a rotary motion up to about 1600 r.p.m. The centrifugal force causes the arms to fly out, bringing the cutters by the impact of vibratory movement in contact with the scale on the walls of the tube. This action causes the teeth to cut into and disintegrate the scale, which is then flushed out by means of a stream of water at hydrant pressure that is fed continuously into the tube by a hose as the process goes on.

The cutting wheels not only remove scale, but when it is removed they lose their vibratory motion and simply burnish the tube, and do not injure or expand the tubes, no matter how thin they are. The effect of burnishing the tubes after cleaning serves to polish the interior, by removing even the mill scale, and so makes it impossible for mineral to adhere tenaciously. This renders subsequent cleaning relatively easy, while it adds greatly to the efficiency of the boilers by improving the circulation, increasing the absorption, and thus economizing in fuel consumption.

The head is adjusted in the tubes by means of a sectional rod united by snap couplings. The rod is given a rotary motion by means of a driving pulley having a sleeve with a key-way through which the rod slides, and by means of a handle at the outer end, the operator can move the head at will back and forth in the tube, while the rotary motion continues.

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For cleaning curved tubes a flexible head of the same shape and a flexible shaft are employed. This shaft, as shown in Fig. 2, is composed of solid brass links of peculiar shape, which hook into each other, and in turn are inclosed in a closely-fitting spirally-wound tube, flat on the inside, which provides a smooth bore in which the link chain operates. The whole is then encased in a tube of specially prepared rubber, not affected by oil, which allows for oil lubrication of the flexible shaft, while it protects it from flushing water, which is led into the tube in the same way as described for the straight shaft.

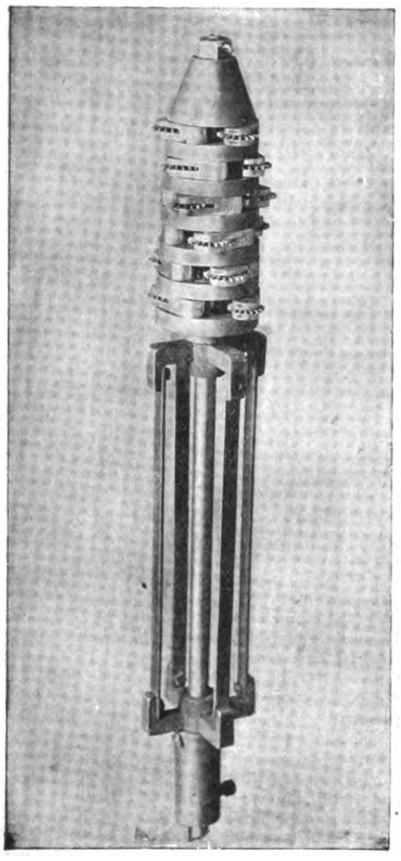


FIG. 1.—WATER-TUBE BOILER CLEANER.

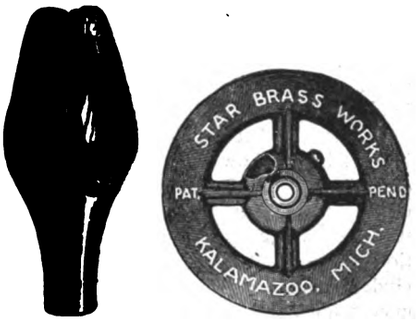
The use of the flexible shaft, which the same company also manufactures, is not confined to the operation of the tube cleaner, but may be employed in any situation where power is to be transmitted, or has been transmitted by any other type of flexible shaft. It is stronger in construction than most shafts of this character, and is especially adapted for use with portable electric motors for drilling or reaming bond or bolt holes in track rails or steel plates of any description.

The tube cleaner and shaft above described are manufactured by the Union Boiler Tube Cleaner Company, Imperial Power Building, 241 Penn Avenue, Pittsburgh, Pa.

### TROLLEY WHEEL FOR HIGH SPEED.

With the high speeds incident to interurban and suburban electric traction, it has been found that the wear on trolley wheels of the usual type is excessive. The accompanying illustration shows a wheel especially designed for the service referred to, though, of course, also applicable to ordinary service and with advantage.

The hub of the wheel is cast hollow and filled with oil, and an orifice leading to the bushing renders the wheel self-lubricating. The wheel is of soft metal, so that it will not injure the trolley wire, being made of the best lake copper especially treated for this purpose by a process owned and controlled by the makers of the trolley. The wheel is made in the standard sizes, 4 ins. and 6 ins. in diameter, and will fit any standard harp. A harp of special design is made, however, so shaped that it will not catch on switches or overhead work should the wheel leave the wire. The forks of the harp are provided with sufficient clearance next the body so that the wheel cannot injure the harp or contact springs.

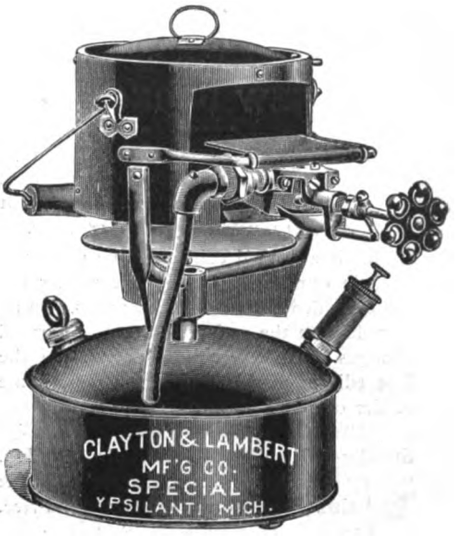



HIGH-SPEED TROLLEY WHEEL.

It is claimed that this wheel is a conductor of very low resistance and that its operation when the wire is covered with sleet is much more satisfactory than that of the ordinary run of wheels. This wheel is used on all of the long-distance lines running out of Detroit, where the service is especially severe, as in some instances the cars are run at from 30 to 40 miles per hour for long distances. The makers are the Star Brass Works, Kalamazoo, Mich.

### ELECTRICAL FIREPOT.

The illustration shown herewith represen an electrical firepot which, it is claimed, will work in the heaviest wind and maintain the highest temperature and efficiency under all conditions of work. The burners of this firepot have cast generators, easily cleaned. A kettle of solder and a pair of coppers can be heated at the same time. When desired the top section of the hood can be removed, converting the firepot into a torch or brazing fire. The burner hangs on a swivel, can be turned in any direction and burns equally well either side up. The manufacturers are the Clayton & Lambert Manufacturing Company, Ypsilanti, Mich.




ELECTRIC FIREPOT.

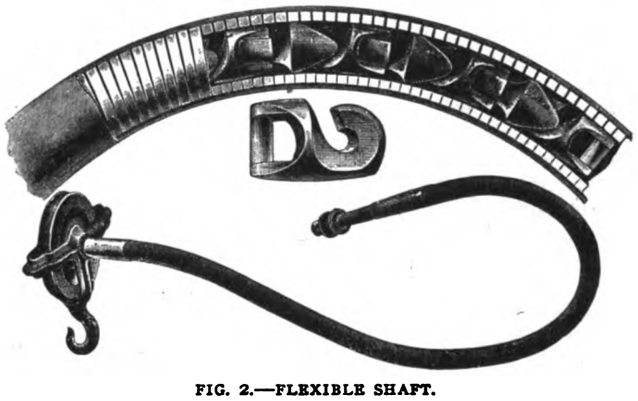
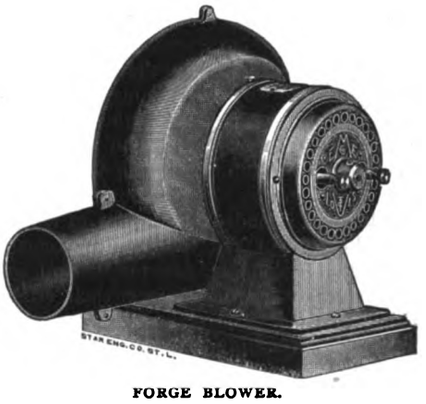


FIG. 2.—FLEXIBLE SHAFT.

### ELECTRIC FORGE BLOWERS.

We illustrate herewith a valuable adaptation of small electric motors for use as forge blowers, and which well deserves the attention of central station men. This is not only the cheapest, but is also the best



FORGE BLOWER.

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method of furnishing blast for all sizes of blacksmith forges. The air pressure is very much heavier than can be procured from any bellows or hand blowers, and in addition it allows the workman to do at least one-quarter more work, as the blast is ready at all times and it is not necessary for him to devote any of his time to producing the air pressure. A great many of these are being used in some of the largest blacksmith shops in the country, and it is found that with its use it is possible to get an even welding heat on a 4-in. axle much quicker and better than can be done by any other system.

The motors furnished, being of the induction type, have no brushes or commutator or other small parts to need adjustment or repair. The Emerson Electric Manufacturing Company of St. Louis, Mo., are the manufacturers.

## NEW BOOKS.

Lighting by Acetylene. By William E. Gibbs. Second edition. New York: D. Van Nostrand Company. 161 pages, 64 illustrations. Price, $1.00.

This is a second edition of the work noticed in our January issue, the matter being extended from 141 to 161 pages. In an introduction the author discusses the rapid changes that have taken place since the first edition was issued, and revises some of the opinions therein expressed.

Standard Handbook for Railroad Men. By A. Kilburn. Chicago: Lee & Laird. 142 pages, illustrated. Price, $1.00.

Why this odd jumble of descriptions, catechism, practical instructions, mileage blanks, "Personal Cash Account," etc., should be called a "Standard" handbook is not easy to see. As much information of direct practical value is contained, the book should, nevertheless, prove of some value to those interested, after he has become acquainted with the arrangement of the matter.

Commercial Management of Engineering Works. By Francis G. Burton. Manchester, Eng.: The Scientific Publishing Company. 310 pages. Price, $4.00.

A systematic treatise on the management of engineering works—shop management—is somewhat of a novelty to the American reader, but there are few who would fail to derive some information of value from the present work. The author states that the book is intended for the use of engineer, the student and the junior foreman, modestly disclaiming any purpose of inducing seniors to depart from their established systems. The various chapters consider the accounting, managing, sales and drafting departments, the shop departments, estimating, forms of shop orders, receipt and issue of material, stock-taking, etc. The division of the book into paragraphs with bold side-heads renders the work particularly convenient to the reader in search of hints that he may apply to a system already established.

Slide-Valves. By C. W. MacCord, Jr., M. E. New York: John Wiley & Sons. 168 pages, 101 illustrations. Price, $2.00.

Of the many books that have been written on the principles and designs of valve gears, the present one appears to be one of the best for the instruction of the practical man. The author does not introduce painfully involved diagrams that will always remain mysterious except to the author, but prefers to use the standard graphical construction, with some simplifications. About a third of the contents is devoted to the shaft governor, which is simply and thoroughly explained. One of the valuable features of the book consists of practical information in detail for setting the various types of valves described.

Electrical Testing for Telegraph Engineers. By J. Elton Young. New York: D. Van Nostrand Company. 264 pages, 91 ilustrations. Price, $4.00.

The object of this book is primarily to supply a manual for submarine cable electricians, comprising a more complete exposition of previous knowledge and a fuller account of its latest development than has yet been published. Overland line testing is, however, included as a necessary part. The work should also prove of service to telephone engineers, and to those in charge of cables for the distribution of light and power. An appendix includes a number of tables and a chart of curves for the localization of total breaks in submarine cables.

Arithmetic of the Steam Engine. By E. Sherman Gould. New York: D. Van Nostrand Company. 77 pages. Price, $1.00.

For the engineer who wishes to know the principles of steam and the steam engine, this little book will be found very useful. Simply-stated explanations are given of such principles, and their application then illustrated by numerical examples. This method serves to impress on the mind of the reader the theory involved, and at the same time enables him to apply it to a practical end. Unlike many elementary books on steam and the steam engine, it is reliable scientifically, and entirely devoid of the padding in the form of mere twaddle, in which "practical" writers so delight to indulge.

Continuous-Current Dynamos. Theory and Practice, with Details of Methods and Formulæ Used in Construction. By T. Fisher Hinnen. London: Biggs & Co. 417 pages, 276 illustrations. Price, $4.00.

This work is an excellent practical treatise on the principles and design of the direct-current dynamo by the late chief draughtsman of the famous Oerlikon Works. The twelve chapters are on theory; armature calculations; design of field magnets; experimental determination of the permeability of iron; graphic solutions of practical problems; relation between brush lead and sparking; design of dynamos for special purposes; constructional details; descriptions of types; relation between weight, dimension and price of dynamos; recapitulation of designing formulæ; tables and diagrams. Five folding plates are included, containing designing curves, an order form and a sheet of cuts showing types of fields. Considerable practical data is scattered throughout the pages, including a table of dimensions and windings of armatures of different types. The book can be recommended as probably the best practical treatise thus far produced on the subject treated. What may be considered a disadvantage by some is the use of the metric system throughout.

## OBITUARY:

MR. EDWIN STANTON CARPENTER, assistant treasurer of the Westinghouse Electric & Manufacturing Company, died in New York last month, at the age of thirty-seven years. His remains were taken to Pittsburgh on Feb. 16 for interment.

JESSE H. BUNNELL, one of the pioneers in the electrical commercial field, and senior member of the firm of J. H. Bunnell & Co., died in Brooklyn on Feb. 8, of heart failure at the age of 56. Mr. Bunnell entered a telegraph office when 11 years old, and at the beginning of the war was an operator at Pittsburgh. Entering the army field telegraph service, Mr. Bunnell served throughout the war; acting as Gen. McClelland's personal telegrapher during the Peninsular campaign, and later joining the army of Cumberland. He made an enviable record, not only as an operator of unusual skill, but for coolness under fire and fertility in expedients. Mr. Bunnell became associated about twenty years ago with Chas. McLaughlin in the electrical business, in which he was engaged at the time of his death. The house he founded will, we understand, be continued under its present name.

MR. JOHN KREUSI, the chief mechanical engineer of the General Electric Company, died on Feb. 22, at his home in Schenectady, his death resulting from an attack of grip, after an illness of only three or four days. Mr. Kreusi was born in Spercher, Canton Appenzell, Switzerland, in 1843, and went to work in a machine shop at an early age. From 1867 to 1870 he lived in Paris, working there in various mechanical industries. At the outbreak of the Franco-German war he went to London, where he stayed for some months, and finally resolved to make his home in the United States, which he reached in December, 1870. After serving with the Singer Sewing Machine Company at Elizabeth, N. J., for two years, he entered the employ of Mr. Edison, with whom he remained as foreman and assistant in experimental work until 1881, when he became general manager of the Electrical Tube Company. Two years later this company was merged into the Edison Machine Works, of which he became assistant general manager, retaining that position both in New York and after the removal of the works to Schenectady. Upon the formation of the General Electric Company in 1892, Mr. Kreusi was made general manager of the Schenectady works, and in 1896 he became chief mechanical engineer to the company, which position he held at the time of his death. During his long connection with Edison, Mr. Kreusi made many important improvements and inventions in machine tools. He was also, from his thorough understanding of the strong and weak points of apparatus, a salesman of more than average ability, when his services were wanted in this capacity. He had a large and varied electrical knowledge, particularly in his keen recollection of numerous experiments which had turned out failures, and of the reason why success along some particular line could not be achieved. Most of all, he was prized by troops of friends, friends for the absolute honesty of every side of his character.

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## PERSONALS.

W. F. D. CRANE, for seven years past with the electrical department of the H. W. Johns Company, has accepted a position with the Electrical Vehicle Company of New York. Mr. Crane being a graduate from the electrical engineering department of Cornell University, unites professional knowledge with commercial training, and is therefore excellently equipped for the duties of his new position.

LIEUT. MANNING K. EYRE has resigned his position as manager of the Edison lamp works at Harrison, N. J., to enter into partnership with Dr. Louis Duncan, the firm name being Duncan & Eyre, engineers. Lieut. Eyre, who is a graduate of the United States Naval Academy, made an enviable reputation as manager of the lamp works, where he had more than a thousand employees under his charge. Uniting with his professional qualities those of a keen business man, he is a valuable addition to the engineering field.

W. W. CHURCHILL.—One of the many characteristics of Westinghouse, Church, Kerr & Co., the well-known engineers, is the promotion of their old employees along with the progress and development of their business. The most important appointment recently made by this company was the promotion of Mr. Churchill to the position of mechanical engineer. Mr. Churchill has identified himself with all of the important contracts handled by Westinghouse, Church, Kerr & Co. during the past nine years. He graduated with the class of '89 at Cornell University, and remained at that institution another year as Sibley Fellow in Mechanical Engineering.

HENRY J. CONANT, who has been well-known as the manager of the Boston office of Westinghouse, Church, Kerr & Co., has been called upon to give his attention to the larger business problems of that concern. Mr. Conant will, however, continue to make Boston his headquarters. As is well known, the entire contract for the new Boston Terminal was executed by Mr. Conant. He was graduated from the Massachusetts Institute of Technology with the class of '87. This, with his many years of experience with Westinghouse, Church, Kerr & Co., makes him thoroughly capable of meeting the greater responsibilities of his new position.

## TRADE PUBLICATIONS.

THE BATES MACHINE COMPANY, Joliet, Ill., has issued a handsome lithograph of the Cookson feed-water heater, which they wish to place in every engine room in the United States. Engineers are requested to write for same.

NEW FAN MOTOR CATALOGUE.—Messrs. D. L. Bates & Brother, Dayton, Ohio, have recently issued a handsome pamphlet describing their fan motors. They will be glad to send a copy to any one interested.

INTERIOR TELEPHONE SYSTEMS.—The Allen-Hussey Company, 211 Randolph Street, Chicago, in a new catalogue illustrates and describes various systems and apparatus for interior telephone communication. Among matters of general interest are a number of covering diagrams.

ESPERSEN SHADE LAMP.—A recent circular issued by the Pacific Electric Company, La Crosse, Wis., shows a number of convenient mountings for the Espersen adjustable shade lamp, the different ones illustrated adopting the shade to almost every possible condition of use.

ROYAL ALTERNATORS.—In an eight-page octavo bulletin the Royal Electric Company, Peoria, Ill., describes its latest type of inductor alternator, which is illustrated in detail by six excellent half-tone engravings. The text consists of an excellently written technical account of the machine.

"NEW LYNN" INCANDESCENT LAMPS.—The Lynn Incandescent Lamp Company, Lynn, Mass., describes in a recent circular its new type of lamp. One of the features consists in anchoring the filament to the glass stem without introducing, as in most cases, an element tending to shorten the life of the lamp.

ELECTRIC MINE LOCOMOTIVES.—The Jeffrey Manufacturing Company, Columbus, Ohio, has issued a pamphlet, having for its subject electric mine locomotives. A number of types are illustrated, varying in size from 2 to 15 tons, and including a switching locomotive which is built up to a capacity of 6000 lbs. draw-bar pull.

THE ANCHOR ELECTRIC COMPANY, 71 Federal Street, Boston, is presenting to its friends a handsomely bound diary memorandum book, containing also much information for ready reference. One excellent feature is a keyed map of the United States, with references for locating 1800 towns and cities, the population and county being also given in the index.

LIGHTNING ARRESTERS.—The Garton-Daniels Electric Company, Keokuk, Ia., has issued an 1899 edition of its catalogue of lightning arresters, in which the latest types are illustrated by excellent engravings. The descriptive matter explains clearly their manner of operation, and incidentally the theory of lightning arresters in general.

LUDEWIG-THURBER MANUFACTURING COMPANY, LTD., 565 Old Avenue, Pittsburgh, Pa., is sending out a work containing 100 views of Pittsburgh. The contents consist of half-tone illustrations of the principal business buildings, residences and general views of various industrial establishments and localities of note in and about the city.

WESTINGHOUSE ENGINES.—The list of artistic engine trade publications has received another addition in a fifty-three-page pamphlet on the Westinghouse standard engine. The engravings are the highest expressions of the half-tone art, and the typography, paper and presswork are in keeping. The pamphlet is largely a technical description of the engine considered, which is illustrated in minute detail.

FAN MOTORS.—The first catalogue of fan motors to reach our desk is a forty-page pamphlet issued by the Western Electric Company. No less than seventeen types of fan motors are illustrated and described, and in addition there are many cuts of accessories, such as receptacles, etc. The descriptions are to the point, and, where necessary, accompanied by instructions for setting up and oiling.

THE AMERICAN ELECTRICAL WORKS, Providence, R. I., celebrated this year's anniversary of Washington's birth by distributing to the trade a fine engraving of the Mansion House at Mount Vernon, the home of Washington. Accompanying it, on a separate sheet, are some interesting facts concerning this historical building and its locality.

THE CARLISLE & FINCH COMPANY, Cincinnati, Ohio, has issued a catalogue of its search light projectors, handsomely illustrated with half-tone illustrations of its various types of lamps, together with a diagram of the connections. The company is now making lamps for all purposes, from a 7-in. lamp for a naphtha or steam launch to the most powerful marine projector. The lamps are said to operate under the most severe conditions, and are not affected by rain, snow, ice, dust, etc.

SYRACUSE ELECTRIC HEADLIGHT.—The Crouse-Hinds Electric Company, Syracuse, N. Y., have issued an extremely unique publication in the shape of a portfolio containing reproductions of letters of indorsement of the Syracuse electric headlight. The portfolio itself consists of a handsomely embossed colored wrapper with a lapel. The letters are produced in fac simile with respect not only to text, but also to size and color of the originals.

MACHINERY AND TOOLS.—The 1899 edition of the Brown & Sharpe Catalogue of Machinery and Tools has grown to 445 pages, in which are included numerous tables which make the book of especial value to workmen as a book of reference. Many additions to the list of machines and tools appear in this edition, in cutters—angular, gear, corner-rounding, double-angle, milling, face-milling, side-milling, etc., grinding, milling, gear-cutting, threading machines, etc.

FIRE AND BURGLAR PROTECTION.—In an artistic twenty-four-page pamphlet the Montauk Multiphase Cable Company, 100 Broadway, New York, sets forth the chief merits of its electrical system of fire and burglar protection. The cheapness and simplicity of this system of protection are, in view of its absolute reliability, among its striking characteristics. As the pamphlet puts it, the multiphase cable is equivalent to a human being in every room or closet on the constant watch to discover and report fires or burglars, with the added advantage that "it never sleeps."

HUNT HOISTING ENGINES, manufactured by the C. W. Hunt Company, New York, are described in a new catalogue recently issued by this company. The illustrations of the electric engines include one of a 20-h.p. electric conveyor driver, built for the Boston Electric Light, Heat & Power Company. The Hunt Company builds electric hoisting engines of various sizes to correspond with steam hoists of like sizes, but makes special hoists for greater or smaller weights, or variations in the speed of hoisting. The motors are wound for 110, 220 or 500 volts, according to the current used. The hoisting speed is varied by controllers and resistances of standard types, and the motor is protected by a circuit breaker, which cuts off the current in case of overload.

MESSRS. BROOMELL, SCHMIDT & CO., LTD., York, Pa., have issued a very complete catalogue devoted to the American fuel economizer, which is a sectional multiple water heater set up in a flue or passage leading from the boilers to the chimney. It is so arranged that the feed-water for the boilers is pumped into it at the end farthest from the boilers, and is discharged at the opposite or hot end of the economizer and delivered into the boilers very hot, from 225 degs. to 350 degs. These economizers can be attached to any type of boiler without stopping the works. In the design of this economizer all packed joints have been eliminated and taper fits are used throughout. Diagrams are given showing the application of the American economizer to various types of boilers.

MECHANICAL DRAFT.—"Artificial draft," so states Mr. W. S. Hutton, "can be readily adjusted to effect the combustion of different kinds of fuel at different rates of combustion. It permits efficient combustion of fuel of inferior quality, and enables a steady supply of steam to be maintained independent of climate and weather. It enables the supply of air to be properly distributed to the fuel in the furnace to effect economical combustion. The supply of air above the fuel can be readily adjusted to effect combustion of the gases evolved by the fuel, and the supply of air below the fuel can be regulated to effect the combustion of the solid portion of the fuel, and the movement of the hot gases can be readily controlled." There is no valuable feature of the chimney that is not possessed by the fan to at least the same, and in many cases to a more marked degree. The very features which are most conducive to economy are those which are incidental to the use of the fan for draft production. While the recent extensive introduction of induced draft in stationary practice has done much to emphasize the advantages of this system, the general superiority of mechanical draft, properly applied, has long been recognized by those who have given careful consideration to the matter.—Extract from Treatise on Mechanical Draft, published by the B. F. Sturtevant Company, Boston, Mass.

## BUSINESS NEWS.

MESSRS. PASS & SEYMOUR have appointed Joseph M. Zamoiski, 515 Equitable Building, Baltimore, as their representative for the Southern States.

ELECTRIC LOCOMOTIVES.—The power and mining department of the General Electric Company has now under consideration twelve electric locomotives for domestic use.

EUGENE MUNSELL & CO. of New York and Chicago, report a very gratifying demand for their India and amber "mica," of which they make a specialty for electrical insulation. Some very large orders have been received at both their Chicago and New York addresses.

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ARTHUR ORGAN, who for several years past has been connected with the Sawyer Electrical Company of Philadelphia, has severed his connection with that company, and is now representing the Jandus Electric Company of Cleveland, Ohio, with an office at 552 Bourse Building, Philadelphia.

THE AMERICAN IMPULSE WHEEL COMPANY, 120 Liberty Street, New York, reports that it has some very large electrical transmission work in hand, and that users are obtaining everywhere the most gratifying and valuable results from their installations of the impulse wheel.

THE GARTON-DANIELS ELECTRIC CO., of KEOKUK, Ia., has just appointed Messrs. Mayer — Englund, 10 South Tenth Street, Philadelphia, Pa., its representatives in the Middle States territory for its line of railway lightning arresters.

JOHN I. DRAKE, 174 Weybosset Street, Providence, R. I., has opened an office at the above address as a consulting engineer. He will also carry a line of electrical and street railway specialties, giving particular attention to the line of switches manufactured by the Hope Electrical Appliance Company, of Providence.

ELECTRICIANS' TOOLS.—A line of screwdrivers which will be found useful in electrical work, such as putting up wires, fixtures, etc., has recently been put on the market by the Sawyer Tool Company, of Fitchburg, Mass. Prices for these tools will be furnished on application to the manufacturer.

DRY BATTERIES.—The Excelsior Dry Battery Company, 8 Third Avenue, Mt. Vernon, N. Y., now manufactures eight standard sizes of the Excelsior dry battery, using round or flat carbons. Two small types, 3 ins. x 1¼ ins. and 2¼ ins. x 1¼ ins., are especially made for use with miniature incandescent lamps.

THE PEERLESS RUBBER MANUFACTURING COMPANY, 16 Warren Street, New York, states that over 1500 tons of "Rainbow" packing were sold during 1898, and that the demand for its packings has increased to such an extent that it has been necessary to run its factory day and night to fill its orders promptly.

MR. JOS. SACHS has been appointed electrical engineer for the Johns-Pratt Company, Hartford, Conn., and the H. W. Johns Company, of New York. The above companies will soon place upon the market an indicating inclosed fuse of Mr. Sachs' invention, which will be introduced to the public at the coming electrical exhibition in the Madison Square Garden, New York.

ELECTRIC MOTORS WANTED.—Leber & Meyer, exporters, 78 Wall Street, New York, request us to say that they want catalogues and prices on electric motors for export, as follows: D. C., 110 and 220 volts, from 1-12 to 1 h.p.; A. C., 110 and 220 volts, 7200 alternations, from 1-12 to 7 h.p.; fan motors for 110 and 220 volts, both D. C. and A. C., 7200 alternations.

THE JENNEY ELECTRIC MANUFACTURING CO., Indianapolis, Ind., U. S. A., at its annual meeting in January, authorized an increase of capital stock from $50,000 to $80,000. Its trade is growing so rapidly that it was thought best to prepare for the rush of trade during 1899. The "Jenney" dynamos and motors are so well known for efficiency and good workmanship that the agents report them very easy to sell.

"JAGABI" PORTABLE TESTING SET.—James G. Biddle, Drexel Building, Philadelphia, has received from the general superintendent of the Canadian Telegraph Service a letter commending highly the "Jagibi" portable testing set in use in that service are stated to have given "perfect satisfaction." A letter from the Somerset Lighting Company, Somerville, N. J., is equally commendatory of this set.

JAMES S. BARRON & CO., 24 Hudson Street, New York, state that they have recently received, among many other foreign orders for their H. P. electric pocket light, orders from such personages as the Duke of York, King of Belgium, Khedive of Egypt and Pope Leo XIII. This device is entering largely into use in the United States Army and Navy and very generally among engineers, machinists, miners, masters of ships, etc.

PRESTON, COHEN & CO. is the name of a new firm of manufacturers' agents for electrical and street railway supplies, recently established in Philadelphia. The office of this concern is at 1004 Real Estate Trust Building, Philadelphia. The firm consists of Albert Preston and Louis Cohen, who have up to recently been connected with the Franklin Electric Supply House of Philadelphia. John M. Young is also a member of the firm.

THE AMERICAN ENGINE COMPANY, Bound Brook, N. J., has received a $30,000 order for its engines from the Louisville "Courier-Journal." This company has also just equipped two large Southern plants with American Ball engines, direct-coupled to generators. These plants are for the Porvenir sugar estate, in Santo Domingo, and the Trinidad Sugar Company, of Cienfuegos, Cuba.

SNOW PUMPS.—The Snow Steam Pump Works, Buffalo, N. Y., and 126 Liberty Street, New York City, have been awarded a contract for a 15,000,000-gal. triple expansion pumping engine for the Calumet and Hecla mines, to be operated with a steam pressure of 185 lbs., the pump to be tested by E. D. Leavitt according to specifications prepared by himself as engineer of the Calumet and Hecla works.

ROTH BROTHERS, whose temporary address is 236½ East Madison Street, Chicago, suffered through a disastrous fire on the morning of Feb. 23, the total destruction of its factory. This will cause a delay in the delivery of many orders, but patrons and the general public are advised that they will resume business at once, or as soon as a suitable location can be found and equipped for manufacturing purposes, which they hope will be very shortly.

CAHALL BOILERS.—The Cahall sales department has found it necessary, owing to the very rapid increase in price of raw materials entering into boiler construction, to advance the price of all boilers of their manufacture 20 per cent, to take effect March 1. This advance has been delayed as long as possible, but materials have risen so rapidly in price and continue advancing so sharply that this step became imperatively necessary.

THE CRANE COMPANY, Chicago, has made plans for the erection of a large new additional plant to its present one on the south side of Chicago, at the junction of Judd and Canal Streets. The new plant will occupy a space of 228 by 94 ft., and be six stories in height, and will cost about $500,000. It will be equipped with the most improved modern machinery, and will also contain a complete electrical equipment for power and lighting.

MR. H. B. MARSH, of the Advance Electric Company, Indianapolis, Ind., spent a couple of days in Chicago recently. Mr. Marsh reports that his firm is doing an unusually large business this spring, and that prosperity is staring them in the face. It is the intention of this company to increase their facilities for the repair of street railway apparatus, in order to take care of the increased orders which they are constantly receiving.

CHAPMAN VOLTAGE REGULATORS.—Among recent sales by the Belknap Motor Company, Portland, Me., of Chapman voltage regulators, are one of 500 kw. to the Northern Electric Company, Philadelphia, and another of the same capacity to the Pennsylvania Light, Heat & Power Company, Philadelphia. Two regulators of 250 kw. each have also been supplied to the Cumberland Illuminating Company, North Gorham, Maine, to control 10,000-volt circuits.

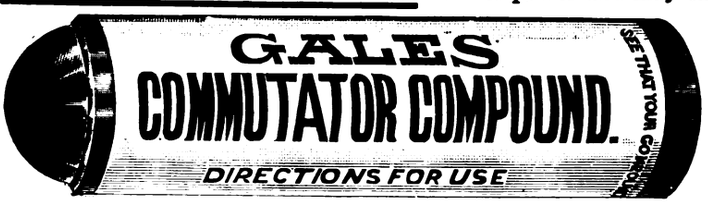
THE FILER & STOWELL COMPANY, Milwaukee, Wis., has received from the Union Railroad Company, Providence, R. I., an order for a cross-compound engine to be direct-connected to a G. E. generator. The engine will have cylinders 28 ins. and 54 ins. x 48 ins., and a fly wheel weighing 100,000 lbs. The same company has also received an order for a cross-compound engine with 24 ins. and 44 ins. x 48 ins. cylinders for the power plant of the Edison Electric Light and Power Company, Erie, Pa.

ELECTRICIANS' TORCHES.—The Clayton & Lambert Manufacturing Company, Ypsilanti, Mich., manufacturers of fire pots, torches, brazing fires, etc., states that never in its history has it been so busy as at the present time. Starting in a small way ten years ago, its line of fire pots, torches and brazing fires is now absolutely complete, and in every possible design used by the average electrician, painter, plumber, tinner or bicycle manufacturer, while special designs are supplied for any purpose desired.

VAN ETTEN ELECTRIC COMPANY, St. Louis, Mo., successors to Ferguson & Van Etten, have just removed to 411 South Second Street, St. Louis, where they will have much larger quarters and increased facilities. This company is meeting with unusual success in the sale of their standard woven-wire brushes, and they are also receiving a large amount of business in the line of street railway repair work. The latter especially has increased to such an extent that the removal to larger quarters was necessary.

QUIMBY SCREW PUMPS.—An order for two No. 10 pumps, each to have a capacity of from 800

**SPARKING** reduces the working capacity of a motor or dynamo, wears out the commutator wastes power and may cause a fire. All of these may be avoided if you use




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to 1000 gals. per minute, with direct-connected electric motors of sufficient power to pump against 150 lbs. to the square inch., has been received by Mr. Wm. E. Quimby, 86 Liberty Street, New York. These pumps were purchased by the Chicago City Railway Company, and are to supply water for the largest electric fountain in the world, to be erected in a park in the southern part of the city.

GATE VALVES.—The Roe Stephens Manufacturing Company, of Detroit, Mich., has recently brought out a new line of extra heavy pressure gate valves. These goods, it is stated, have met with an extraordinary demand during the active business of the past six months, both in government and private work, at home and abroad. They are used in a large number of the electric railway power houses and electric light plants, where high pressure is used, and in waterworks and other municipal plants.

THE LYNN INCANDESCENT LAMP COMPANY, of Lynn, Mass., has recently opened a New York office in the Electrical Exchange Building, 136 Liberty Street, and has placed Mr. Wm. N. Famous in charge. The company is just issuing a very readable little treatise on the renewing of burned-out lamps. Wherever it is possible an expert will be sent from the New York office to ascertain the exact requirements as to voltage, efficiency, etc., on receipt of inquiries or orders, and in this way suitable lamps will always be supplied.

MICANITE.—The Mica Insulator Company of New York and Chicago invites electrical engineers who are not already familiar as to the value of "Micanite" as an insulator for commutator segments and rings to write to it regarding the same. It makes a specialty of furnishing segments for any style or type of machine, and has manufactured some segments recently as long as 80½ ins. and 4 ins. in height. Builders of electrical apparatus will, upon application, receive a copy of the company's sheet insulation manual and data book. It not only gives the break-down tests of its insulations, but contains samples of the goods it manufactures.

THE PELTON ENGINEERING COMPANY, Cleveland, Ohio., has leased the property at 1076 Hamilton Street, now occupied by the Parrish & Bingham Company, and will take possession on April 1. It will at that time have under one roof probably the most complete electrical supply and repair house to be found in the Central States. The company is exclusive agent for the Eddy Electric Manufacturing Company, Shaeffer meters and transformers, and has several lines of station supplies, brushes, etc. It has just completed arrangements whereby it will put out an incandescent lamp bearing its own label, and also guarantee.

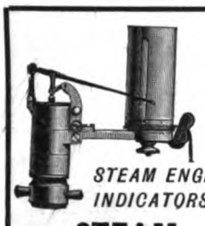
THE WARD-LEONARD ELECTRIC COMPANY reports strong and rapid increase in business since the beginning of the year. Its goods are used very largely abroad, and many very handsome orders have been received by the company lately, a single order from a German manufacturer being for over five hundred rheostats. The company makes the claim that it has never yet had a single case of repairs upon its circuit breakers, this being due to the fact that the two independent switches, one upon each pole, make the circuit breaker self-protecting. This feature in the Ward-Leonard circuit breaker is a strong point in its favor.

FLICKERING OF LIGHTS.—Evidently a remedy has been found for the most annoying trouble of flickering of electric lights. The Cling-Surface Manufacturing Company, of Buffalo, has received many unsolicited letters lately, expressing the effectiveness of cling-surface on dynamo belts by the prevention of all flickering of lights. It is self-evident that this flickering is caused by the slipping of belts, and, as a belt full of cling-surface runs steadily and positively, beyond all possibility of slipping, the importance of the fact can be seen at a glance. As all engineers know this flickering usually occurs when the plant is being pushed hardest, and when the best results are desired.

LOWE & LEVERIDGE.—Mr. Ernest A. Lowe and Mr. Charles W. Leveridge, late of J. Jones & Son, have entered into partnership under the above firm name, and will conduct a general electrical supply business at 183 Greenwich Street (between Courtlandt and Dey Streets), New York. Mr. Lowe has had thirteen years' experience in the electrical field, beginning in 1886 with Pearce & Jones, at 79 John Street, and was subsequently with the Western Electrical Company, United Electric Light & Power Company, and J. Jones & Son. Mr. Leveridge has been in the electrical field for seven years. Both of these gentlemen have had such a wide experience in construction work and in the electrical supply business that the new firm has every assurance of success.

RESISTANCE WIRE.—Wilbur B. Driver & Co., 126 Liberty Street, New York, make a specialty of resistance wires for all kinds of work. Their "Climax" wire for high resistance is claimed to have forty-five times the resistance of copper (almost three times 18 per cent German silver), and a temperature coefficient of .00042 per degree Fahr. For measuring instruments and work requiring constant resistance at all temperatures they have a material thirty times copper, and negligible temperature coefficient. Still another wire, with about the same resistance as German silver, has half the temperature coefficient of it, and is much better mechanically. These wires cover quite fully the demands for resistance material.

THE SHELBY ELECTRIC COMPANY, of Shelby, Ohio, manufacturers of the well-known "Shelby" and "Y-Ray" incandescent lamps, have opened a permanent office in New York City in the Fidelity and Casualty Building, 97-103 Cedar Street, with Mr. John F. Outwater in charge. Mr. Outwater's numerous friends in the trade will no doubt be surprised to learn that he has made the change from buyer to seller. For the past ten



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CROSBY — ALL PARTS RENEWABLE

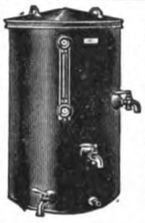
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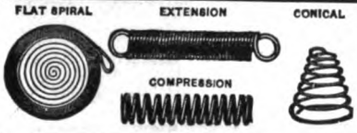

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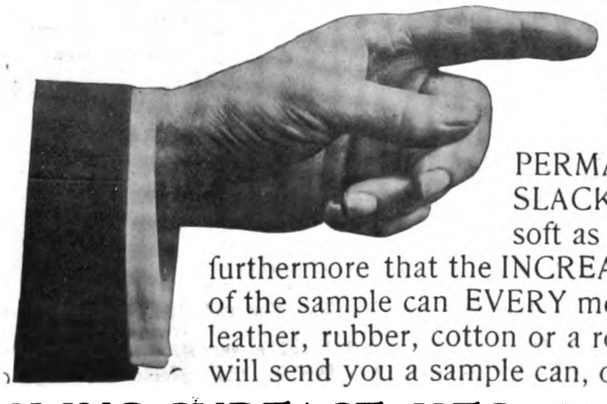

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CLING-SURFACE MFG. CO., 188-194 VIRGINIA STREET, Buffalo, N. Y.


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years Mr. Outwater has been connected with the Brooklyn Edison Company, in various responsible positions; lately as purchasing agent, and the numerous friends which he has made as buyer will no doubt be glad to reciprocate when in position to do so, now that he is on the other side of the counter. Mr. Outwater states that he is in position to furnish the trade with any and all types of lamps, ranging from 1/5 to 50-c.p., and from 2 to 250 volts.

BOILER TESTS.—Prof. R. C. Carpenter, during the month of November of last year, made an interesting test of the boiler plant of the Youngstown, Ohio, light companies, the object being to determine the relative efficiencies of two sets of three boilers each, equipped with patent furnaces for smoke consumption and economy. The figures in Prof. Carpenter's report show that the three boilers equipped with Murphy stokers developed more horse-power than the three boilers of the other set, and evaporated more water per pound of fuel, notwithstanding that the former had somewhat less heating surface and height of chimney, and that they were fired by the regular fireman of the works, while the competing furnaces were fired by an expert fireman sent on from the works. The labor was also much less in the case of the Murphy furnace, the single regular fireman working alone and taking his coal from a wagon in front of the fires, while in the other case, the coal was laid down in front of the furnaces by helpers, and the work of the fireman was so heavy that it was necessary to relieve him for about two hours during the trial.

ST. ANTHONY FALLS POWER HOUSE.—The equipment of the power house at the lower dam of the Falls of St. Anthony at Minneapolis, Minn., is about to be completed, and the necessary arrangements have been made by the St. Anthony Falls Power Company with the General Electric Company, which manufactured and installed the plant now in operation. The hydraulic work and the power house were finished in the spring of 1898, and five three-phase alternators of 700 kw. each, and two direct-current generators of the same capacity, with the necessary rotary converters and static transformers, were installed. The full equipment of this power plant as originally laid down contemplated the use of eight alternators and two direct-current machines of a total capacity of 10,000 h.p. The present plant has been in full operation since May of last year, the current being used to drive the street and interurban railway systems of the Twin Cities Rapid Transit Company, which operates the electrical railways of Minneapolis and St. Paul. The additional equipment will consist of three 700-kw. three-phase revolving armature alternators, with rotary converter, step-up and step-down air blast transformers and switchboards for the generators and converter. The installation of this machinery will bring the generating capacity to the 10,000 h.p. originally contemplated.

LARGE CONTRACT FOR VITRIFIED CONDUIT.—The American Vitrified Conduit Company, of New York, has been awarded the entire electrical conduit contract for the city of Baltimore, which calls for several million feet of multiple-duct vitrified conduit. The ducts vary in number from two to sixteen. The Vitrified Conduit Company has various contracts on hand at the present time, including one for 1,000,000 ft of duct for the Narragansett Electric Light Company, Providence, R. I.; also one for the Edison Electric Illuminating Company, and another for the Western Union Telegraph Company, at New Orleans, La.

IMPROVED OUTLET BUSHING.—An investigation of electrical fires has shown that in house wiring considerable trouble has occurred at the outlets. It frequently happens that wires are brought out through ordinary bushings, which have resulted in a very unsatisfactory job, which seldom withstands the onslaughts of the lathers, plasterers and other artisans. The improved outlet bushing invented by Mr. Jacque Morgan, city electrician, Kansas City, Mo., is said to insure a safe and substantial job. After this bushing has once been nailed, it cannot be moved from its position. It is estimated that a saving of over 28 per cent on the gross cost of each outlet can be effected by using this device at list price. The bushings are extra heavy and made of the best porcelain. The dimensions are: Length, 3¾; inside diameter, ⅝; outside diameter, ¾ ins. Mr. Morgan will be pleased to give further information and prices of this and his other insulating specialties.





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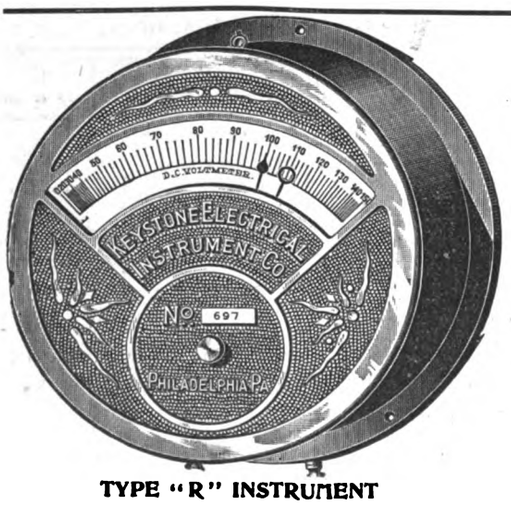
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# American Electrician.

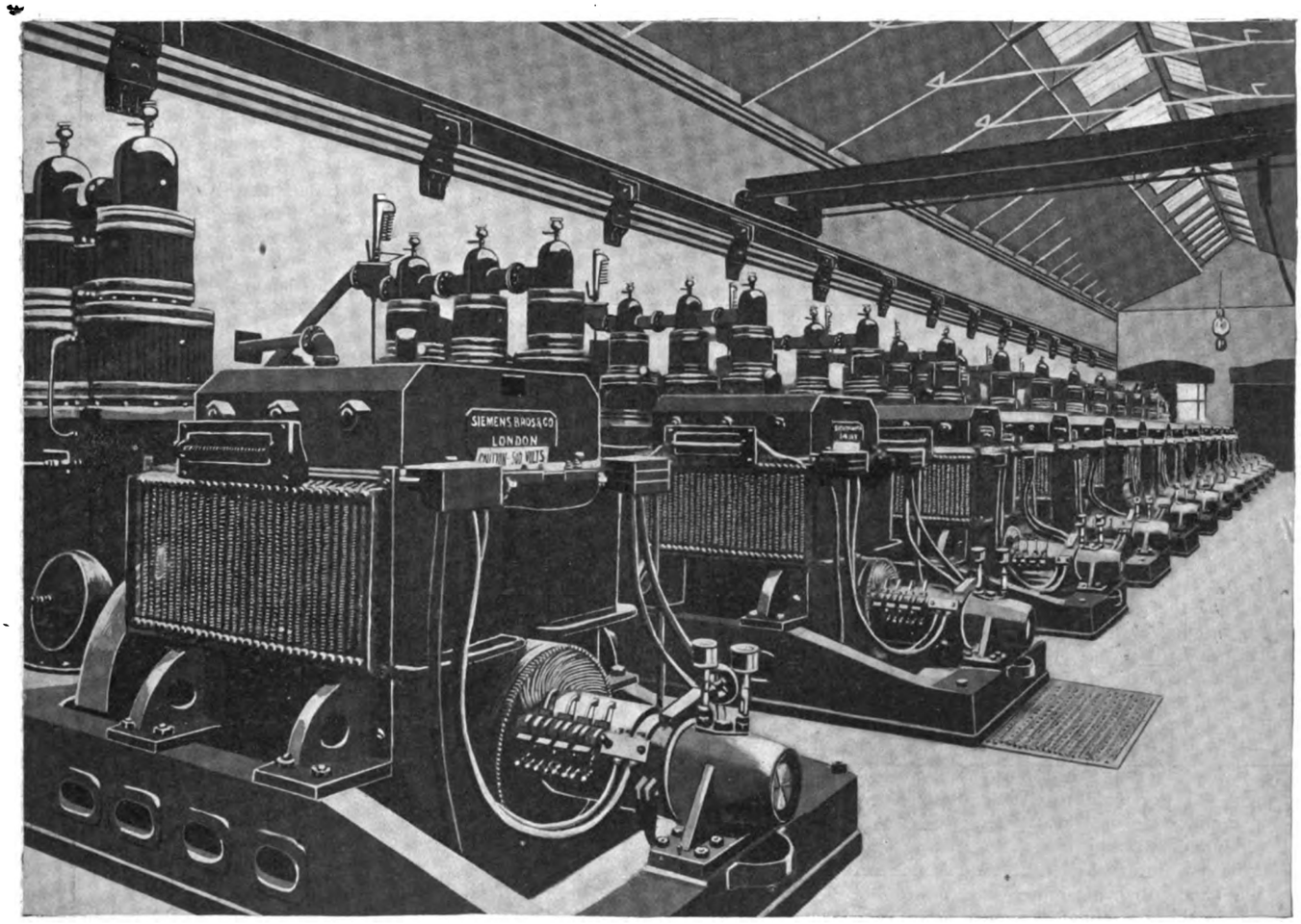
Vol. XI. New York, April, 1899. No. 4.

## THE POWER HOUSE OF THE STREET RAILWAY SYSTEM IN LIVERPOOL.

### ENGLISH AND AMERICAN PRACTICE COMPARED.

The City of Liverpool is unique in that the municipality owns and operates both a central station and the street railways, or, as the English would put it, the corporation owns the electricity works and the tramways. The electric lighting and street railway plants thus can be and are under one roof, taking steam from one battery of boilers and for the present utilizing but one type of engines and even of generators.

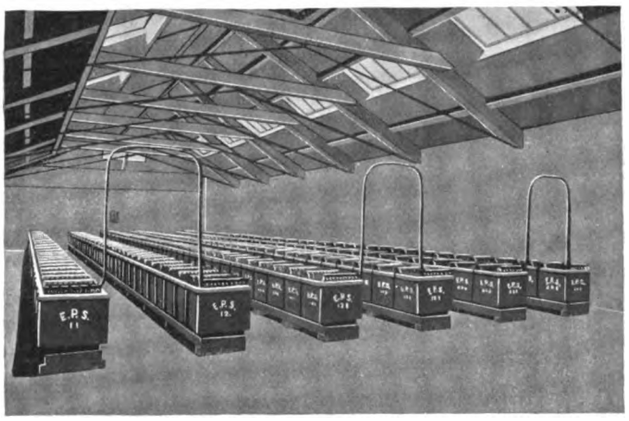
The main engine room, which appears in the accompanying illustration, is very long and narrow, with an astonishingly large number of small units, judged by American standards, running down one side of the room and flanked by their switchboards, which run along the wall just beyond the right hand limit of the picture. The three generating sets in the foreground of the view shown are devoted to the street railway load and consist each of a 300-h.p. Willans engine coupled to a bi-polar generator. The engines are of the three-crank steeple compound single-acting type, with the valves working in the piston rods, which are now coming to be known here through their more recent introduction on this side of the water.




THE ENGINE ROOM OF THE COMBINED LIGHTING AND RAILWAY POWER STATION IN LIVERPOOL.

In the Liverpool plant they are worked non-condensing. Each engine is coupled

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THE STORAGE BATTERY ROOM.

to a Siemens under-type bi-polar generator, similar in general style to the Edison machines manufactured in this country ten years ago. The dynamos are 550-volt machines with shunt fields and the field rheostats are mounted in a way that appears odd to the American engineer, that is, on the sides of the machines themselves. The vertical coils of resistance wire can be clearly seen in the illustration. The armatures of the dynamos are of the smooth body construction, that is, without teeth or slots.

This general design of direct coupled sets is very popular in England, being widely used for loads, which in this country would be carried by high-speed horizontal engines in small sizes and Corliss engines in large sizes, with multipolar generators in both cases. The Liverpool plant is to have three larger generating sets of the same type, each of 1500 h.p. capacity.

An idea of the dimensions of such units as compared with units of the same output of American manufacture can be gained from the fact that the floor space of those to come in Liverpool will be 24 ft. by 13 ft. 6 in., the overall height being 19 ft. 4 in. A feature about these large sets, which would horrify American street railway engineers, is the fact that they will have no flywheels, the weight of the armature alone being considered sufficient.

The switchboard of the plant is also shown in an illustration on this page. It carries three panels, the left hand one being the main board, the middle for the booster, and the right hand one what is called in England the Board of Trade panel. On the main panel are mounted four double-pole switches and single-pole fuses for connecting the three dynamos and the one storage battery to the one pair of bus bars, an equalizer bus being unnecessary in this station as the machines are not compounded. The switches differ from American instruments in that each pole consists of a U-shaped piece or knife working into clips, which are separated by a barrier. The I.T.E. circuit breaker in the middle of the panel and the Weston round type instruments are familiar, but the integrating meters at the top of the board and the recording meter above the circuit breaker are comparatively strange.

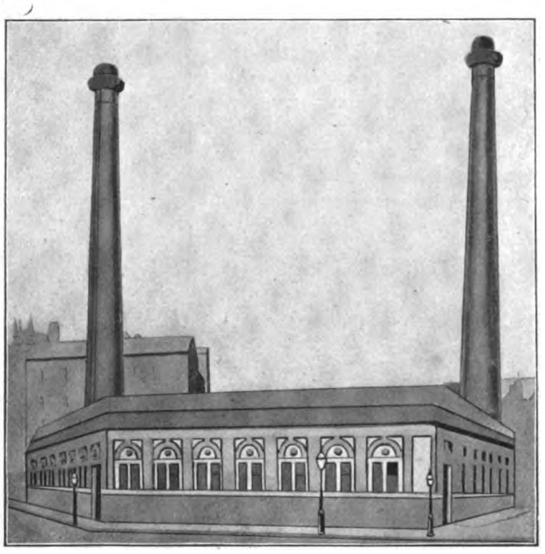
The booster panel contains switches by which the feeders may be thrown either direct to the main bus or through the booster. It appears that the latter is a group of three machines coupled together, a 500-volt motor driving two series-wound generators. These machines are capable of carrying the current in the long feeders and are adjusted to boost it by a voltage equal to the drop in the feeders, so that the pressure at the distant feeding point shall be the same as in front of the station. One of these generators is connected in the trolley feeders and one in the return feeders from the rail boosting thus both polarities.

The Board of Trade panel is a regular feature of English railway plans and is equipped with instruments which are required by the Board of Trade rules for determining and recording the drop in the rails, which is strictly limited to a a maximum of 7½ volts, and for measuring the current which can be picked up from a well-grounded plate.

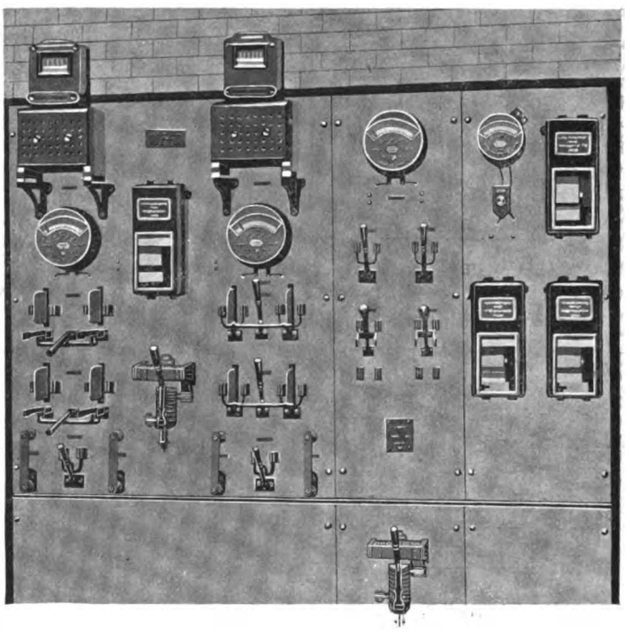
The current is carried from the station to the points of distribution by underground cables with vulcanized bitumen insulation, both line and return current feeders being insulated. The cables are not drawn into conduits as is the practice in this country, but are laid solidly in cast iron troughs, so that the streets must be excavated when trouble occurs. The feeders end in switch pillars or pillar boxes where switches are located, by which they can be cut off from the overhead copper in one case, or the rails in the other case. Besides these cables there are what might be called pilot wire cables, one to comply with the Board of Trade regulations, its conductor connected to the rails to give an indication on the Board of Trade panel of the drop in the rail return.

Another cable with three conductors is also run out, two of these being used for telephone purposes and the third as a pilot wire. These cables are lead-sheathed and armored with steel tape and yarned, and are simply laid in the excavation without any conduits.

The storage battery consists of 246 cells, with a capacity of 480 ampere hours at a one-hour discharge rate They are located in a spacious battery room, the American practice of double-decking to economize space, not being followed. They are connected straight across the bus bars without a booster, the drop of the dynamo voltage with increased load serving to throw the fluctuations of the demand upon the storage battery.



AN EXTERIOR VIEW OF THE POWER HOUSE.



THE SWITCHBOARD.

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# Electric Fan Motors—1899 Models.

Although the users of electric fans may be expected to devote little thought and less money to this piece of apparatus for a month or more to come, the supply dealers must at this early season take time by the forelock and plan for the demand which they have learned becomes greater year by year, and the manufacturers have already

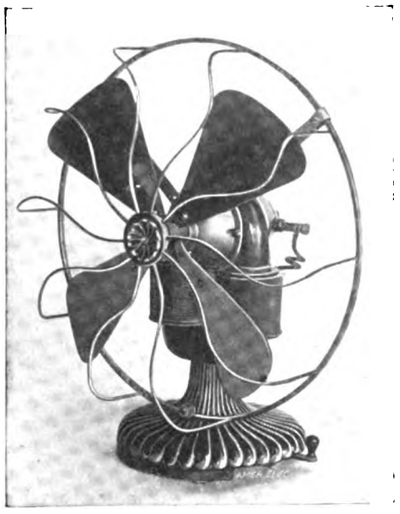


FIG. 1.—THE PEERLESS DESK FAN.

been busily at work for several months improving their designs, constructing special tools and industriously piling up a stock which they know will melt away when the hot weather arrives.

The improvements of this year's types over previous models exhibit more than ever before the care which manufacturers have learned must be taken in the minutest details of the construction of apparatus made in such large quantities as are fan motors. The general trend of design is clearly toward the abolition of cast iron in the magnetic circuit and the substitution therefor of forged, or, preferably, of laminated field magnets. In the matter of bearings, the self-aligning bearing, generally of phosphor bronze, has been almost universally adopted where two bearings are necessary, but one single long bearing with the armature overhanging one end and the fan blades the other shows an increasing popularity, due undoubtedly to its comparative simplicity and rigidity.

Practice is sharply divided on the question of enclosure, some motors being tightly enclosed, so that dust is kept out of the working parts, and others opened partly to give ventilation and warning in case trouble occurs with the brush or commutator, which, if enclosed, would often be utterly burned out before the trouble was detected. More care is taken this year than ever before in the concealment of wires and binding post within the motor shells and the packing of bearings to prevent the throwing of oil. Practice differs on the question of overhung or underhung oil cups, some preferring a grease cup above the shaft and others an oil cup below with an upwardly pressing wick. The use of waste saturated with oil and resembling in principle the ordinary car journal is recommended by some, while at least one maker uses the loosely depending oiling ring dipping into a reservoir, a miniature of the form so widely used in dynamo bearings.

The noise of what is called the "buzz" fan—originally due to faulty motor construction—has been of late years cut down practically to the humming of the blades. Some makers this year have produced a blade with a peculiar configuration, which they claim eliminates this source of annoyance. Besides the various general types of fans such as desk, bracket, ceiling, column, etc., made for the various kinds of voltages and current, some designs are specially strong in certain features, while others meet peculiarly well the individual requirements of certain applications. A study of the machines described and illustrated below may help those interested in the subject to find the fan which meets their particular needs.

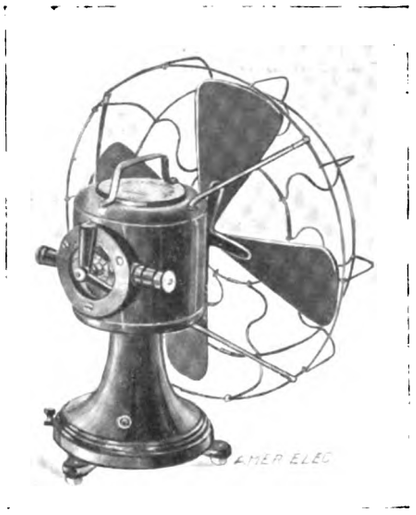


FIG. 3 —THE TOWLE DESK FAN.

Fig. 1 illustrates a desk fan for direct currents with the bipolar U-type field and hemispherical shells over the two ends of the armature, rendering it dust proof. The pedestal of the fan is fitted with the usual switch and a striking appearance is obtained by finishing the fields and base with a black enamel, making the enclosing hoods of lacquered brass, the blades and guard being of the usual polished brass.

A new model of fan motor with many interesting features is shown in the four il

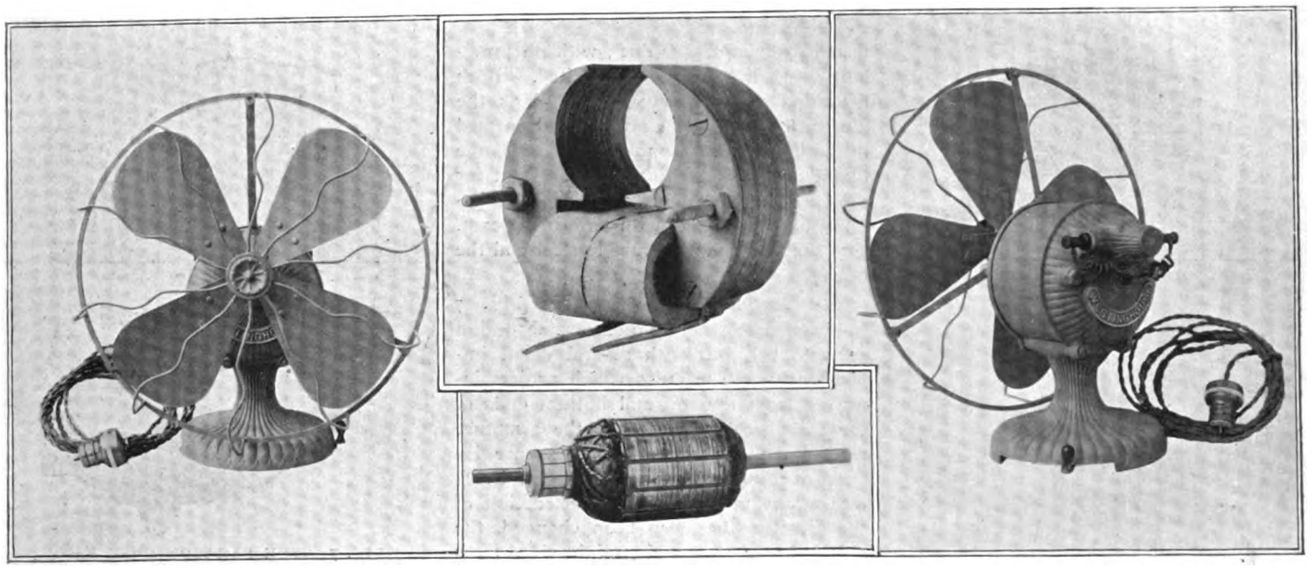


FIG. 2.—THE WESTINGHOUSE FAN MOTOR AND ITS PARTS.

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lustrations of Fig. 2. As the detailed view of the interior parts shows. the field is crescent-shaped and made up of laminated steel plates, giving the body of the motor a circular contour with the fan centre above the centre of the body. The field laminations are tightly bound together by screws

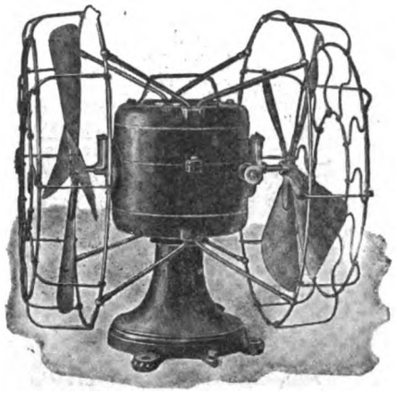


FIG. 4.—THE TOWLE DUPLEX FAN.

and the two through bolts which fasten the field to the end plates or brackets, maintaining the armature in alignment with the bore of the poles. The field is wound with two coils and these are so connected with the starting switch that either or both of them may be used, giving three different

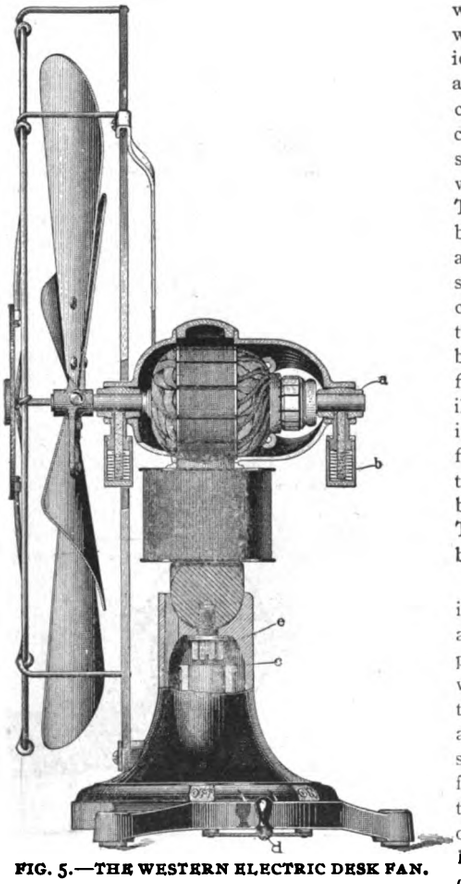



FIG. 5.—THE WESTERN ELECTRIC DESK FAN.

speeds, without the use of any dead resistance. The armature teeth overhang the slots and with insulating strips hold the conductors in place without binding wires. The motor complete with attachments weighs 23 pounds.

The desk fan shown in Fig. 3 has two special features, one the convenient handle screwed to the top of the case and the other the arrangement of the bearing at the commutator end. This is as shown mounted on a large circular ring with a three-arm spider allowing the inspection of the commutator, and of such proportions that its removal allows the ready replacement of the armature. The case is of the vertical cylinder type, which is coming into considerable favor in fan motor designs. A duplex fan, comprising a single motor, coupled to two fans with blades oppositely pitched so as to throw the air outward in each direction, is shown in Fig. 4.

The direct current fan shown in Fig. 6 differs only in minor details from those of the same make put on the market last year. The bracket fan is fitted with the usual two swivels, one allowing it to be rotated about a vertical and the other about a horizontal axis so that its blast may be delivered in any direction whatever. The view of the desk fan shows it with the back half of the iron-clad hemispherical body removed, exposing the armature and fields and showing the manner of their construction. It will be noted that field coils, which are form wound, are bent back so that the armature may be slipped out without disconnecting a single wire. There are no outside wires leading to the brush holders and further, while the fans are furnished with switches allowing four speeds, the contacts are completely enclosed in the base so that they are protected from injury or dust, with no possibility of their being short circuited. Both field and armature are laminated as the illustration clearly shows. Incorporated in the body of the fan are grease cups, one filling of which provides the lubricant for the entire season, doing away with the liability of dripping, as with an oil lubricant. The shaft is made of crucible steel and the bearings of phosphor bronze.

The familiar fan shown in Fig. 7 is in its main features of the same design as last year, but with several detail improvements. The poles which project inwardly from the top and bottom ends of the cylindrical field toward the armature are, in the 1899 model, made square instead of round, giving a greater useful surface at the air gap. The construction of the armature has also been changed, the old V-shaped slots and straight sided teeth having been replaced by tunnel slots and overhanging teeth, doing away with the need of binding wire, and improving the magnetic action. These changes, with improved materials, have allowed the weight of a 12-inch fan to be reduced by four pounds, bringing it down to about 13 pounds; the 16-inch coming down from 25 to 18 pounds.

In the simplification of details, the lugs by which the upper half of the field was fastened to the lower half have been done away with. The two screws which fasten the handle and name plate to the top of the motor now run straight down through and

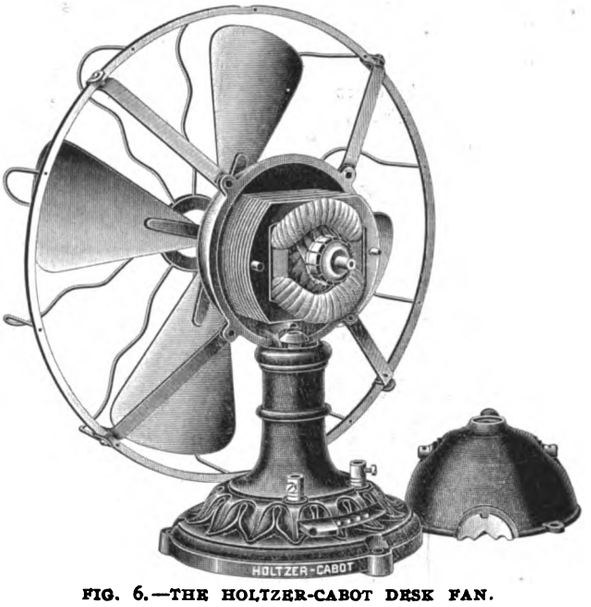



FIG. 6.—THE HOLTZER-CABOT DESK FAN.

fasten the two valves of the motor together, thus performing three useful functions. The carbon brush is now made with a square, instead of with the flat cross section of last year. and as before slides in a brass box in a black fiber tube. All wiring is done inside the motor shell, there being even no binding posts exposed, and the brass caps at the end of the brush holders are insulated, so there is no possibility of a shock or short circuit from the exposed parts of the motor. The bearings are self-aligning, and the front bearing is supported in a spider

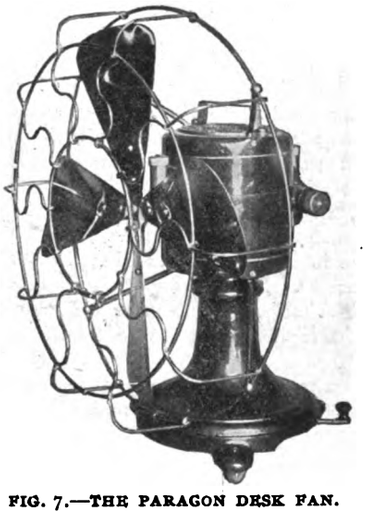


FIG. 7.—THE PARAGON DESK FAN.

which can be removed by taking out two screws, allowing the armature to be slipped out without taking the field structures to pieces. The starting rheostat under the base is of the enameled type on a porcelain plate.

A desk fan, which shows how ingeniously all the refinements of construction

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can be obtained with the small number of parts allowable in a fan motor, is illustrated in Fig. 5. The motor is of the bi-polar type with a drop forged magnet and an enclosing shell protecting the commutator but leaving sufficient opening for the detection of sparking. The brushes are of graphite. The journals are self-aligning.

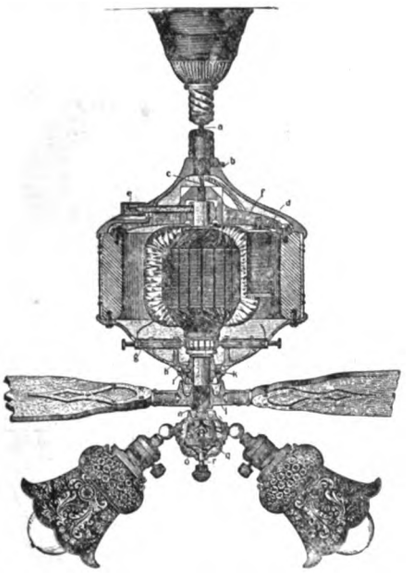


FIG. 8.—SECTIONAL VIEW OF WESTERN ELECTRIC CEILING FAN.

of Babbitt metal and slipped into cylindrically bored bearings in which they are retained by the stems of the oil cups. The chambers of the latter are filled with a heavy cylinder oil, which is carried up to the bearing by means of a wick pressed against the shaft by a coiled spring. A starting switch, giving three speeds, is mounted on




FIG. 9.—A WALL SWITCH AND RHEOSTAT.

a porcelain base under the pedestal which contains a rheostat of German silver wire insulated with asbestos and mica on a porcelain spool. The 550-volt motor is fitted with a double pole, quick break switch.

The ceiling fan illustrated in Fig. 8 shows evidence of the same careful design. The motor is bi-polar, with a circular enclosing yoke, the armature shaft running in self-aligning bearings similar to those in the desk fan. The armature shaft is tubular and inside of it is another tube through which run the wires to the switch and electrolier below the fan blades. The starting resistance is mounted on a porcelain spool inside the field frame of the motor. Below the upper journal is a small oil pan to prevent any oil coming from the upper bearing from running into the armature. A small hole leads from this pan through the tubular shaft allowing the oil to drain into the pan below on the top of the switch box. Still another pan in the hub carrying the fan blades catches oil from the lower journal.

For use with this fan there is provided a special wall switch rheostat, by means of which three speeds can be given to a single fan or to a group of fan motors connected in series on high-tension circuits. The style for a single motor is shown in Fig. 10 and for the group in Fig. 9. The latter is made up with the different resistances necessary for running various combinations of the different styles of fans on the different voltages customary on supply circuits.

An ingenious arrangement for reducing the speed of an alternating current motor

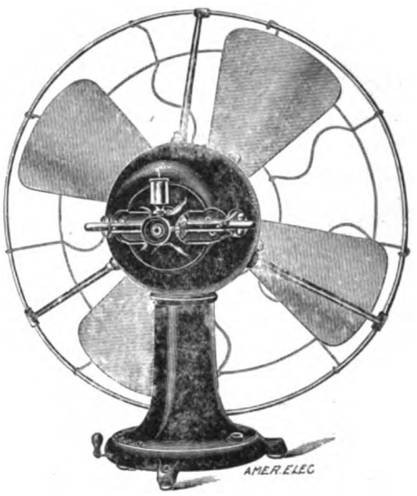



FIG. 12.—THE HURRICANE DESK FAN.

to that necessary for ceiling fan work without noisy gears or troublesome belts is shown in Fig. 11. Here the motor is shown mounted on a spherical ball bearing and driving a small friction pinion. This engages with two large leather faced wheels on hinged inclined shafts. On the outer surface of these wheels the spherical enclosing case hangs and to it are attached the fan blades. The motor armature runs at a high speed turning the intermediate pulleys at a moderate speed, and the outer case at a still lower speed. The whole constitutes a very compact and simple speed reducing device. The handle at the lower end of the motor is arranged to change the angle of the blades at will. A small wheel is also fitted with a rod running up to a switch within the motor casing.

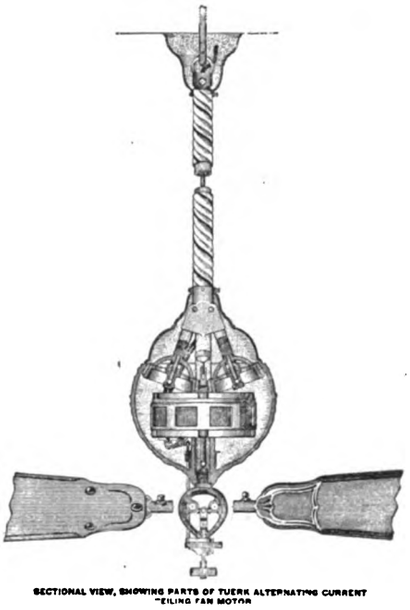
Several improvements have been made in this year's construction of the Hurricane fan motor, as will be seen by reference to Fig. 12. The motor remains of the enclosed type with exposed commutator and brushes, but the field enclosing ring is now almost spherical in shape. The brushes are square and arranged for easy replacement. The bearings are of phosphor bronze self-aligning. The armature is easily removed by unscrewing the front




FIG. 10.—A WALL SWITCH AND RHEOSTAT.

bearing. A three-speed rheostat is fitted on a slate base. Double silk covered wire is used in the armatures of the 12-in. motors, and double cotton covered wire in the armatures of the 16-in. The wall fans are made with a ball and socket joint, so that the breeze can be directed both downward and to the side.

The fan shown in Fig. 13 has been de-



SECTIONAL VIEW, SHOWING PARTS OF TUERK ALTERNATING CURRENT CEILING FAN MOTOR

FIG. 11.—SECTIONAL VIEW OF TUERK ALTERNATING CEILING FAN.

signed with a motor body showing a spherical contour. The upper half of the sphere is removable to give ready access to the armature. One pole projects downward inside the upper hemisphere, and the other upward in the lower hemisphere, the

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field coils filling the spaces between these polar projections and the shell, making a very compact motor, as all space within it is usefully occupied. The armature is as usual of the slotted type, with overhanging teeth and no binding wires, wound with double silk-covered wire. The crucible steel shaft runs in self-aligning bearings fitted with depending oil cups containing felt wicks. The guard is attached at its lower point directly to the base, without the usual yielding brace, making the guard remarkably stiff.

Some handsome designs of desk and bracket fans are shown in the group Fig. 14. Two models of the direct-current type are shown in the two right hand illustrations, that to the extreme right representing the new type known as the "house fan." It is a single speed fan intended to give a moderate breeze, with noiseless running and low current consumption. The motor is entirely enclosed and differs in that respect from its neighbor to the left, which is a more powerful multiple speed fan and

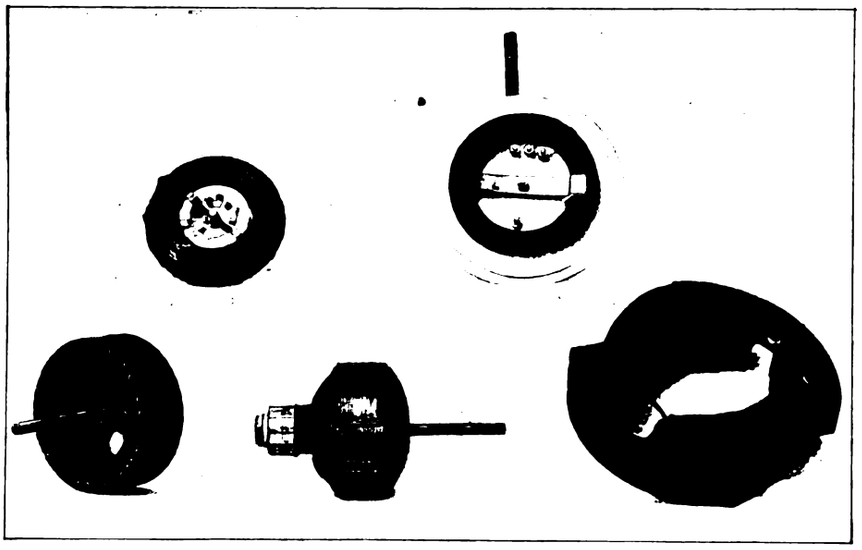
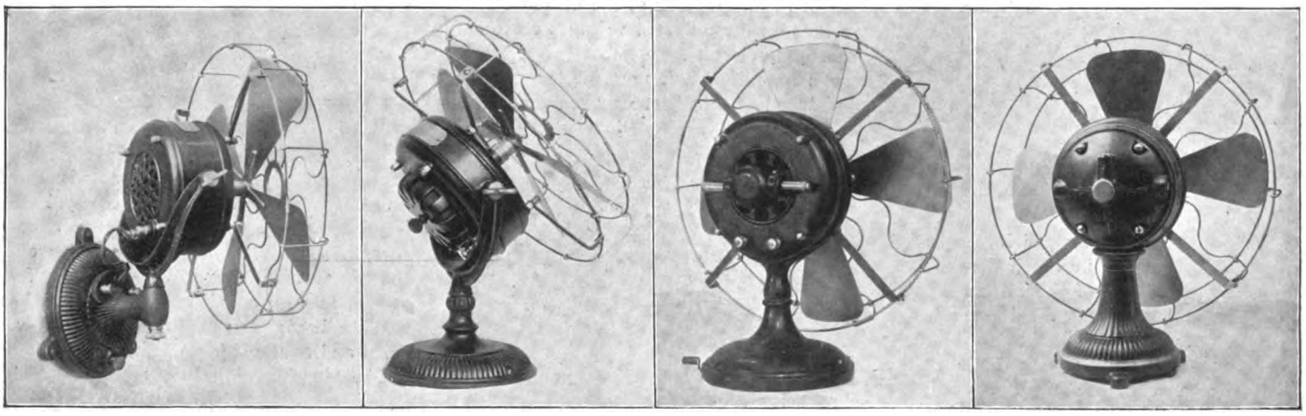


FIG. 15.—DETAILS OF GENERAL ELECTRIC FANS.



IG. 14.—THE GENERAL ELECTIC COMPANY'S ALTERNATING BRACKET, ALTERNATING DESK, DIRECT DESK AND DIRECT "HOUSE" FAN.

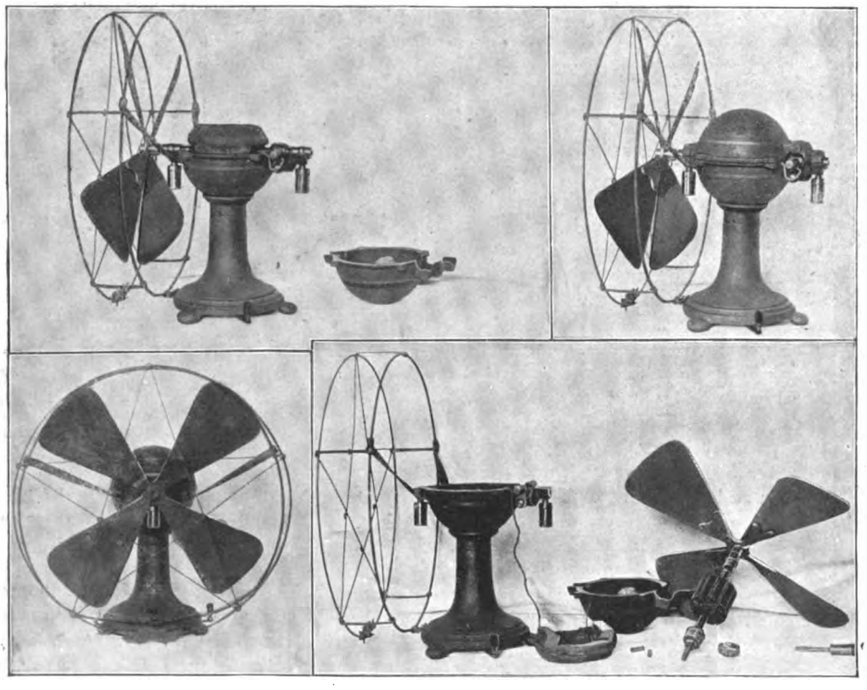


FIG. 13.—ROTH BROTHERS' FANS DISMOUNTED AND ASSEMBLED.

requires ventilation, for which it is provided with openings. This motor is peculiar in that it has only one bearing, an unusual feature in direct-current fans. This is a long tube or sleeve bushed with bronze and running deeply into the armature, the commutator over-hanging this bearing and projecting into a cup or bulb on the end plate of the case. This armature is shown clearly in the illustration of various details, Fig. 15, where its unusually large diameter in proportion to its length is clearly indicated. The same figure shows also the laminated steel field-magnet, which is ingeniously designed to give a bipolar field and to take form-wound field coils without any break in the magnetic circuit.

To the left of the direct-current motors in Fig. 14, are shown two alternating current fans, one designed for desk and the other for bracket mounting. The former has a speed controller, consisting of a coil concentric with the motor shaft and cut into or out of circuit by the thumb switch at its centre. The bracket fan has the same coil fitted within the base of the bracket, the thumb switch projecting through the casting. The motor is of the same construction as last year, with the pole-wound field having four poles for the

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7200 alternation model, and the usual short-circuited squirrel-cage armature, a view of which is shown in Fig. 15. The rotating field for starting is obtained by means of short-circuited copper strips enclosing the corners of the poles and acting as "shading coils." These fans are made with trunion supports which give an adjustment much easier to control than does a ball and socket joint below the machine, as when the latter is loosened the motor tends to flop over.

The fan motor shown in Fig. 19 will be instantly recognized by electrical engineers as the well known design in which one single field coil, concentric, but not co-axial with the armature, energizes both poles. There are several great improvements in this year's design. In the first place, the cast iron field of former models has been replaced by drop forgings of high grade steel, the two which constitute the field poles and yoke being exact duplicates and interchangeable. The high permeability of this material allows a much thinner cross section, permitting the field coil to be twisted until its axis is more nearly in line with the shaft, so that the coil does not interfere with the endwise movement of the armature when it becomes desirable to remove or replace this part. The bearings are self aligning and fitted with hanging oil cups. The guard is of a very rigid construction, as the practical test illustrated in Fig. 17



FIG. 17.—THE LUNDELL GUARD.

clearly shows. Notwithstanding this rigidity it is of pleasing appearance. The guard is attached through only one brace, being fastened to the pedestal or base of the desk fan at two points.

The alternating current fan of the same manufacture is unique in that its motor is of the synchronous instead of the induction type, by which a much larger output from the same amount of material is obtained and the annoying lagging currents are entirely eliminated. The construction may be explained as follows: The external primary is built up of laminated iron with eight internally projecting poles, each wound with a coil supplied with alternating

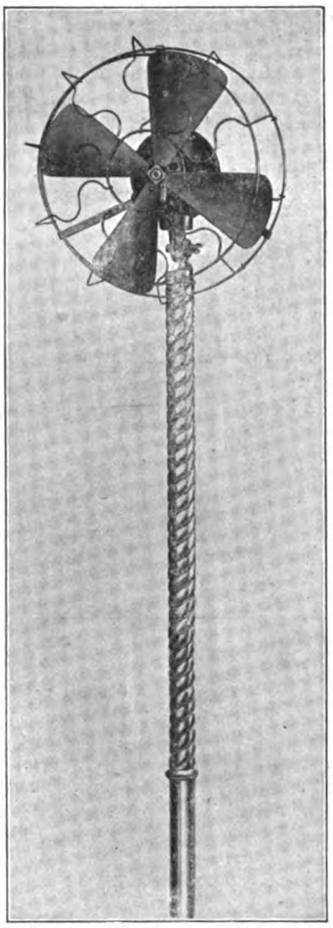


FIG. 18.—A LUNDELL "BUZZ" FAN ON A COLUMN.

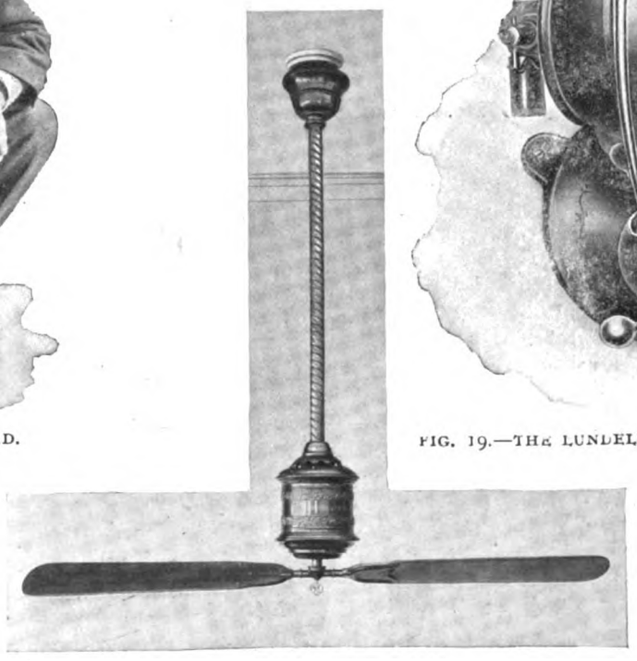


FIG. 16.—THE GENERAL ELECTRIC CEILING FAN.

currents. No auxiliary coils or phase displacing arrangements are used whatever. The internal rotating part or armature is laminated, slotted and wound with two circuits, one of which is short-circuited in a suitable way to act as a secondary to the eight poles. The other is connected up to a disc-shaped commutator. A pair of brushes bear on this commutator, connecting it in series with the field circuit. On starting, the machine acts as does any series motor, both armature and field magnetizations reversing simultaneously, thus giving a pulsatory torque always in the same direction. As the machine runs up in speed the short-circuited secondary winding takes hold and gives a powerful torque, as an induction motor running the speed almost up to synchronism. At synchronism the commutator obviously acts as a rectifier, giving a pulsatory direct current to the rotor winding connected to it. This pulsatory direct current sets up direct magnetic poles in the rotor which react on the a. c. field and make of the machine a synchronous alternating motor, with an internal rotating field magnet energized by the rotary transformer action of its commutator. At synchronism, of course, the short-circuited winding exerts no torque at all, but it does serve in connection with the self-induction of the rotor iron to smooth out by the currents induced in it the pulsatory magnetization of the rotor teeth, and

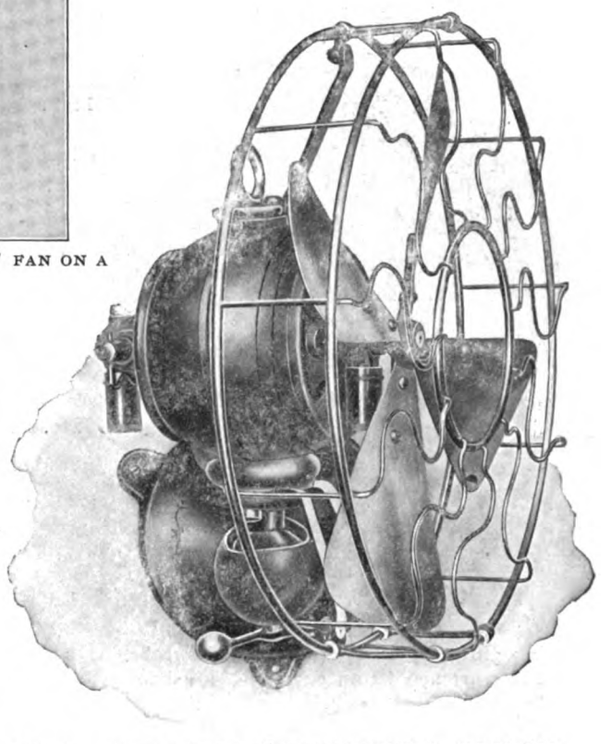


FIG. 19.—THE LUNDELL 1899 BRACKET FAN AND MOTOR.

thus renders this magnetization practically constant. This field can be made very strong, thus giving a high power factor or even leading currents.

An electrolier fan, wherein the four fan blades are attached above the moving part of the motor within the basket, is shown in Fig. 21. It is made in the usual voltages, 110, 220 and 500, and also for 167 and 250 volts for running in groups of three or of two, series connected across 500-volt circuits. The machine is provided with but

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a single self-oiling bearing, extending the entire length of the motor. The armature hangs around this bearing much as do the rotating parts of the mammoth Niagara generators, giving a very stiff alignment of fields and armature. The switch at the bottom of the motor housing is inclosed

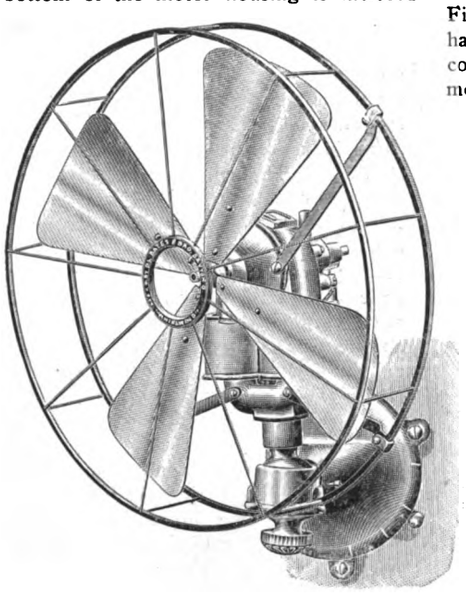


FIG. 20.—A 16-INCH BATES BRACKET.



FIG. 22.—FIELD OF EMERSON MOTOR.

in an inverted cup of the casing, so that the electrolier may be set on the floor without breaking off the switch handle. Fig. 20 shows a 16-in. bracket fan of the same make, built with a bipolar forged steel magnet. It is swiveled on one ball and socket-joint, allowing motion in any direction either vertically or horizontally. This fan is also furnished with a base when used as a portable desk fan.

An alternating current motor for desk or bracket fans which makes the term "buzz fan", a misnomer, is shown in its assembled form in Fig. 24. The most conspicious peculiarity about this fan is the novel ear-shaped configuration of the blades, the following edges having a peculiar curve which the makers claim does away with the buzzing noise so often an accompaniment of high speed fans. The details of the motor construction have been carried out with great care. In its general principles the motor is of the usual induction type with a short circuited secondary, the conductors of the latter being copper straps closed upon themselves as Fig. 23 clearly shows. The shaft is a case-hardened steel tube pressed into the back cover, the armature or rotor being mounted on a tubular hub or sleeve which slips on to this tubular shaft. The detailed construction of this bearing is shown in Fig. 25, where M is the central shaft with screw plugs C and I at its two ends and an oil well A, feeding oil to its interior. The



FIG. 23.—ARMATURE OF EMERSON MOTOR.

tubular hub of the motor armature bears upon the central shaft through two bearing sleeves F and oil is admitted to the wearing surfaces through the holes L. To absolutely prevent any throwing of oil a felt washer is mounted at D, which is obviously the only point at which oil can escape. By unscrewing the fan, which has a left-hand thread, taking off the front cover and removing the plug screw I the rotating parts may be slipped out. To prevent any oil from coming out from the front on to the fan blades and being thrown to surrounding objects, the fan hub forms a screw plug which seals the end of the armature head.

A similar blade to that described above is also used in the fan shown in Fig. 28, and is in this case termed by the manufacturers the "New Departure" blade. The

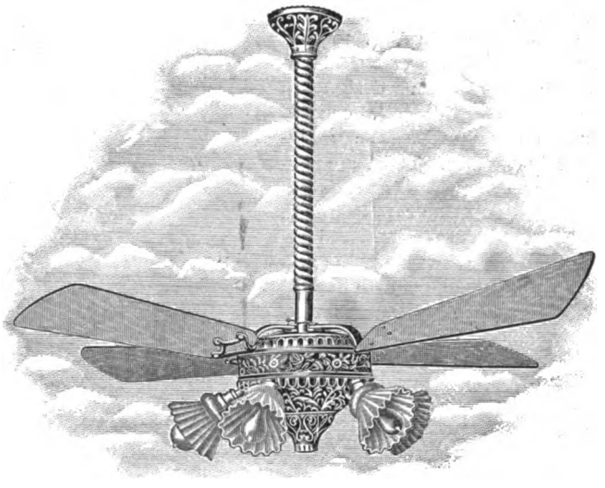


FIG. 21.—THE BATES STATIONARY ELECTROLIER FAN.

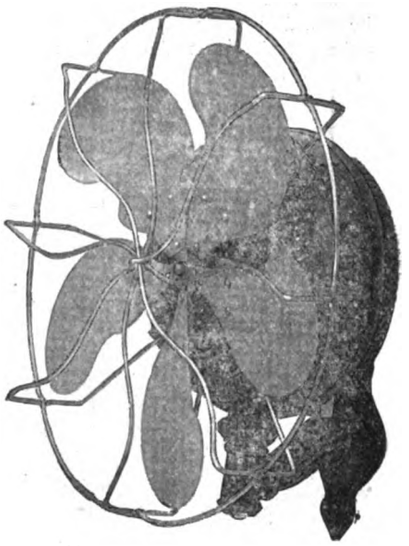


FIG. 24.—THE EMERSON BRACKET FAN.

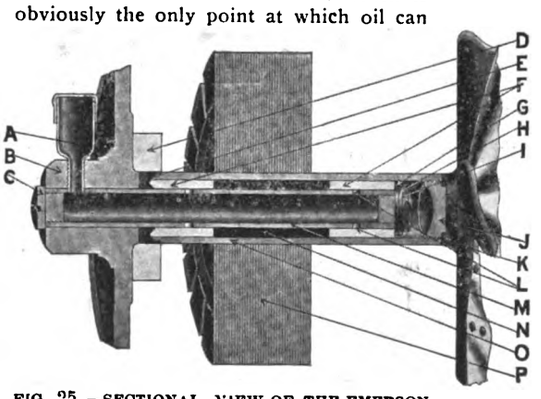



FIG 25.—SECTIONAL VIEW OF THE EMERSON BEARING.

ceiling fan of the same make is shown in Fig. 26. The peculiarity of this fan is the fact that the commutator, which is at the top of the motor, is always in sight. The armature is of the drum type with an external field

The construction of the motor of a ceiling fan with ingeniously arranged parts is clearly indicated in the cross section reproduced in Fig 30. The motor is bipolar with a field magnet crossing the shaft and wound with single coil N. This energizes the peculiarly shaped poles L, which have a deep channel section embracing three sides of the armature I. This in turn is fastened by screws X, to the lower part of the enclosing case, and

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through it drives the fan hub A. The thrust bearing is immersed in oil in the chamber in this fan hub.

A view of the alternating current ceiling fan of the same make is shown in Fig. 29. Here the primary or field circuit is wound on a toothed and laminated core, mounted on the spider, and the armature or secondary revolves outside of it. The armature drives the fan blades through the lower part of the enclosing shell, the rotating parts resting on a ball bearing in an oil cup, and supported by the fixed hollow steel shaft, which is one inch in diameter. Fig. 27 shows an alternating current desk fan of the same make, which is fitted with a knock-down or removable guard, allowing an easy access to the blades and bearing. There is one bearing extra long of phosphor bronze and lubricated by an oiling ring, similar to those used on dynamos.

A fan called the "search light," because its blast can be turned in any direction, vertically or horizontally, is shown in Fig. 31. The flexibility of its support is obtained by the combination of a swivel and a trunion, the adjustments being maintained by hardened cup-pointed set screws. The motor body, although inclosed, is provided with openings for ventilation. The motor has two self-aligning bearings, and the cover on the commutator end is fitted with an extension inclosing the armature and a further extension carrying the bearing. The base of the motor is recessed for a snap switch, which is also a speed controller.

The construction of the motor of the ceiling fan manufactured by the same concern is admirably designed as follows: The upper bearing runs in an oil cup which is attached to and revolves with the armature shaft so that no oil can leak out of it into the armature. Its walls are contracted toward the top so that the oil will not fly out of it by centrifugal force. The lower bearing is imilarly arranged and the vertical thrust is taken up by a ring of hardened steel balls. Two different styles of field magnets are made for this fan, one of the circular yoke type, with removable steel pole pieces projecting inward toward the armature, and the other of a single iron casting, with poles ingeniously shaped so as to receive the field coils, as is shown in Fig. 32.

The detail construction of the motor of another direct current ceiling or column fan is extremely interesting, and is shown in Fig. 35. The armature is of the Gramme ring type, running in a bi-polar field, generated

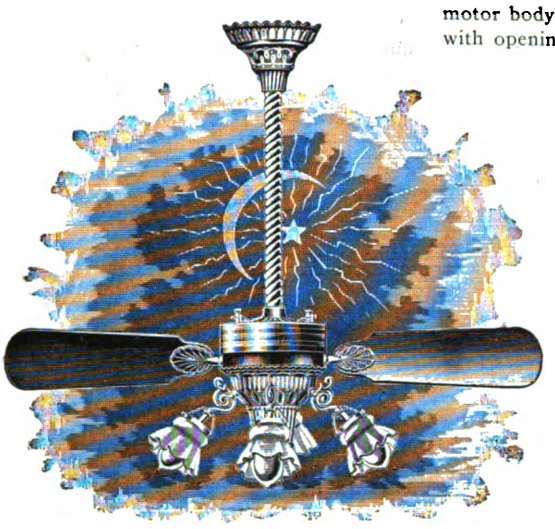


FIG. 26.—THE CRESCENT FAN WITH FOUR-LIGHT ELECTROLIER.

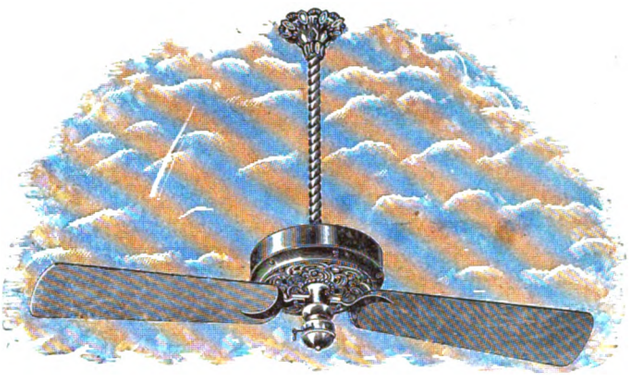


FIG. 29.—THE DAYTON ALTERNATING CEILING FAN.

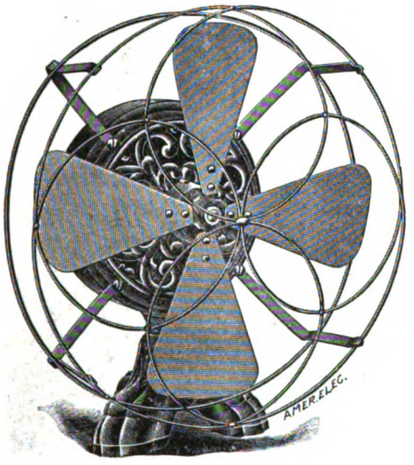


FIG. 27.—THE DAYTON ALTERNATING DESK FAN.

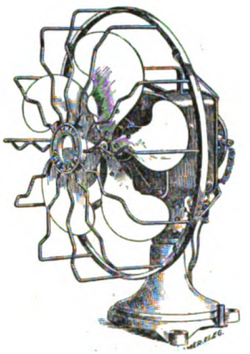


FIG. 28.—THE CRESCENT DESK FAN.

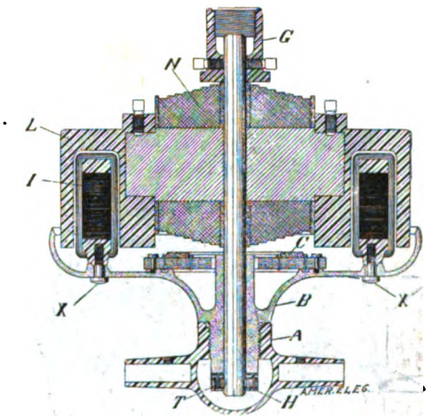



FIG. 30.—THE DAYTON DIRECT CURRENT CEILING FAN MOTOR.

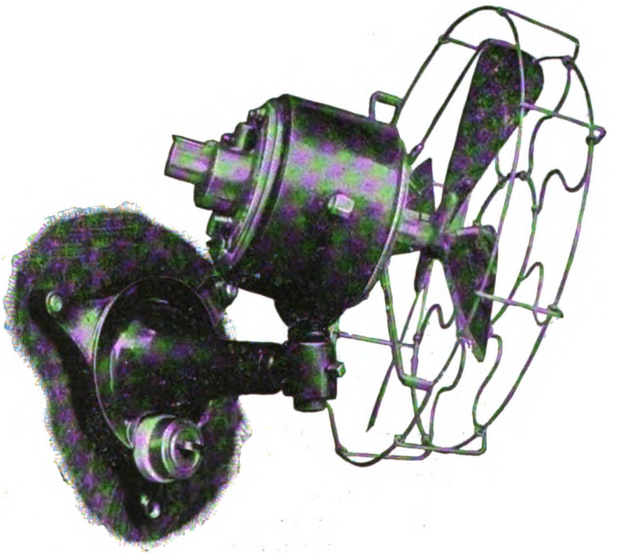


FIG. 31.—THE STANDARD SEARCH-LIGHT FAN WITH BRACKET MOUNT.

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by a magnet immediately below it. The commutator is of the flat disc or radial type, with two downwardly bearing brushes pressing upon it. The shaft is a tube through which runs a rod attached to the switch below, and the armature overhangs the single long bearing running down through the field. Lubrication is effected by grease contained in a pocket in the middle of this long bearing and the construction is such that by no possibility can any grease escape from below, the hemispherical shell of the fan being integral with the hub of the blades and revolving therewith.




FIG. 32.—A FIELD MAGNET FOR A STANDARD CEILING FAN.

The ceiling fan shown in Fig. 38 is so arranged that by the removal of three screws the armature may be taken out without detaching the fan from the ceiling. The rotating parts are supported on a ball-bearing running in an oil cup of sufficient size to furnish lubrication for an entire season. Fig. 33 shows a desk fan made by the same manufacturers, the most prominent feature of which is the absence of any breaks in the magnetic circuit. The fan is not divided in a horizontal plane as is usual in fans of this shape, but is split vertically, the cover, which forms one side of the case, being removable without separating the poles.

A battery fan ingeniously designed to obtain maximum output from the small power available from a primary battery with the absolute simplicity of parts necessary in such a small motor is illustrated in Fig. 36. The motor has a single field coil and a pole-wound armature with six teeth or poles. The fan is fitted with four blades and the usual guard. The 6-in. fan requires two, the 8-in. fan three and the 10-in. fan four cells of Gordon primary battery.

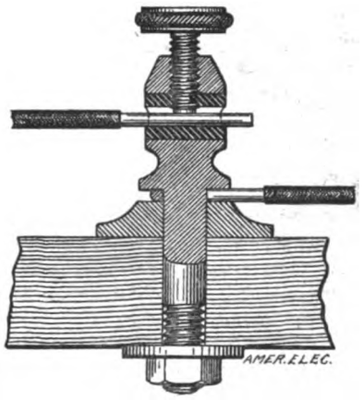



FIG. 34.—THE SWITCH OF THE FULLER FAN.

Fig. 37 shows a battery motor in which one part has been ingeniously designed to do the work previously required of two. The baseboard switch is replaced by a simple modification of one of the binding posts which will be clear on inspection of Fig. 34. The wire entering the binding post, runs through an insulated sleeve or bushing, through the wall of which the binding screw projects. By simply loosening the screw the current is turned off and by tightening it turned on again, so that the only addition to the parts otherwise required in a binding post is the insulating sleeve. This simplification is covered by patent.

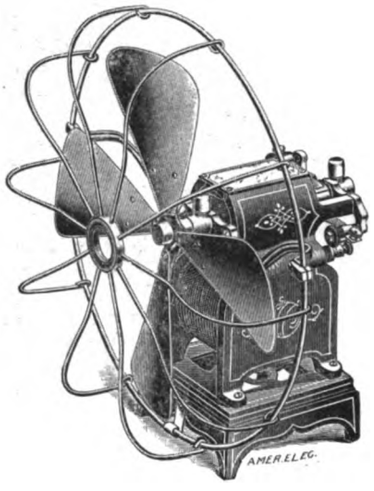



FIG. 37.—THE FULLER BATTERY FAN.

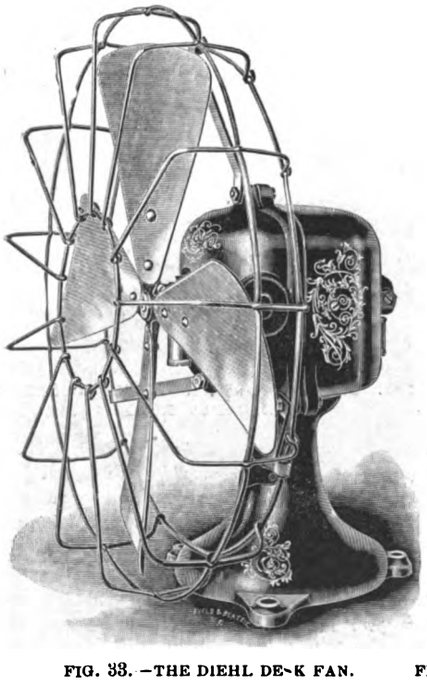


FIG. 33.—THE DIEHL DESK FAN.

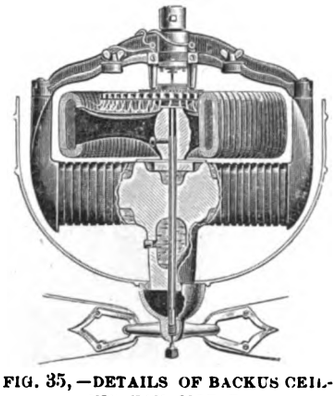


FIG. 35.—DETAILS OF BACKUS CEILING FAN MOTOR.

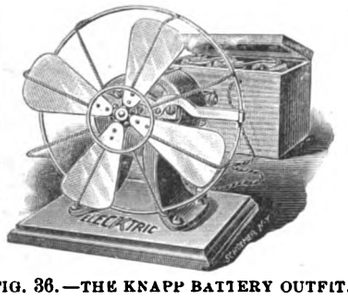



FIG. 36.—THE KNAPP BATTERY OUTFIT.

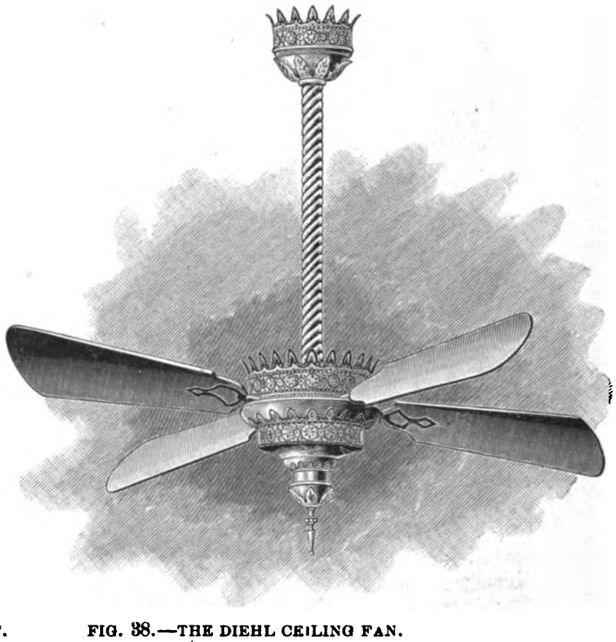


FIG. 38.—THE DIEHL CEILING FAN.

For locations where dynamo power is unavaliable, the primary battery must be depended upon for current, and good results can be obtained if a battery of sufficient output is installed. The ordinary gravity battery gives an economical source of current but will only stand a slow rate of discharge, so that a large battery would be required to give sufficient power to run a fan. By using a storage battery continuously charged by the proper gravity battery and intermittently discharged at a higher rate when the fan is used, a moderate sized gravity battery is made valuable for fans of no mean power. Such a combination is that represented in Fig. 40, which shows a box containing six "Ex-

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cello" improved gravity cells charging a two-cell storage battery in a separate case, which in turn feeds a small four-volt motor carrying an 8-in. fan, represented on the lid of the battery box. In case continuous service is wanted from the fan, another primary battery of the same number of cells may be used in multiple with the first, and the storage battery dispensed with. The storage cells are practically sealed to prevent the spilling of their contents and are fitted with capped vent tubes, which appear in the illustration. The fan motor is of the ironclad type, fitted with one long self-oiling bearing.

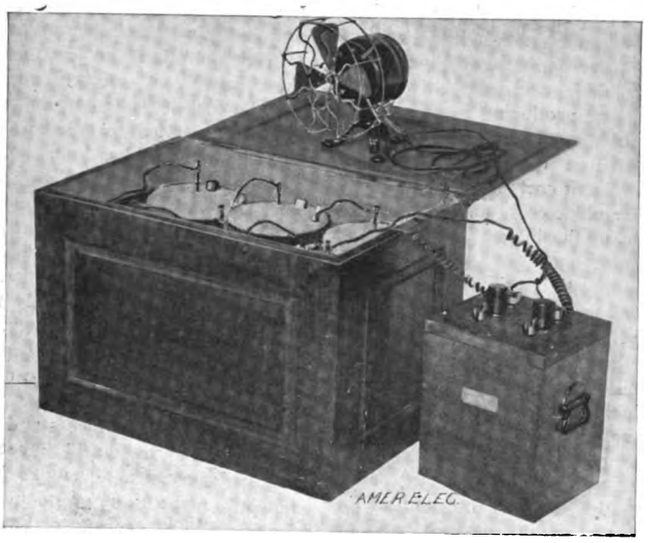



FIG. 40.—THE EXCELLO FAN AND PRIMARY AND STORAGE BATTERY OUTFIT.

An outfit specially designed for and of obvious value in a telephone booth is illustrated in Fig. 39. Its use is not limited to any time or season, as every telephone booth is close at any time of the year. The motor is specially designed to run noiselessly and produce no vibration, absolute requirements in this service. It is suspended from ornamental brackets by means of two helical springs. It is wound for battery voltage and may be connected in series with the incandescent lamp, if there is one, within the telephone booth, the switch on the motor starting both lamp and fan when the booth is to be used and cutting both off when the booth is vacant.

With the coming of hot weather the necessity arises for renewing the air in interiors as well as setting it in motion. For this purpose motor driven ventilating fans or air propellers are now very widely used. Fig. 41 shows a belted combination of this type using a single-phase self-starting induction motor. The motor and fan are provided with two-step cones, so that the speed of the fan can be changed by transferring the belt.

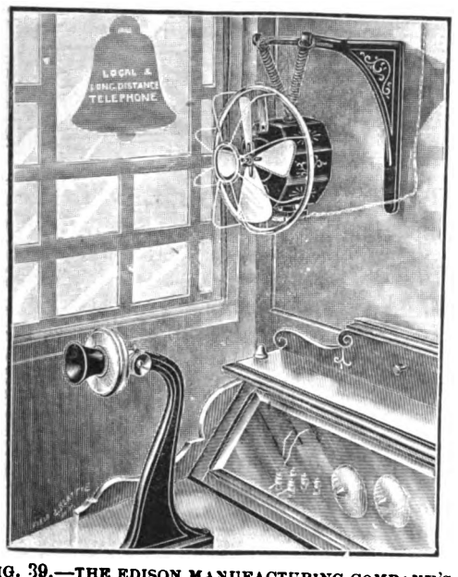



FIG. 39.—THE EDISON MANUFACTURING COMPANY'S FAN FOR TELEPHONE BOOTHS.

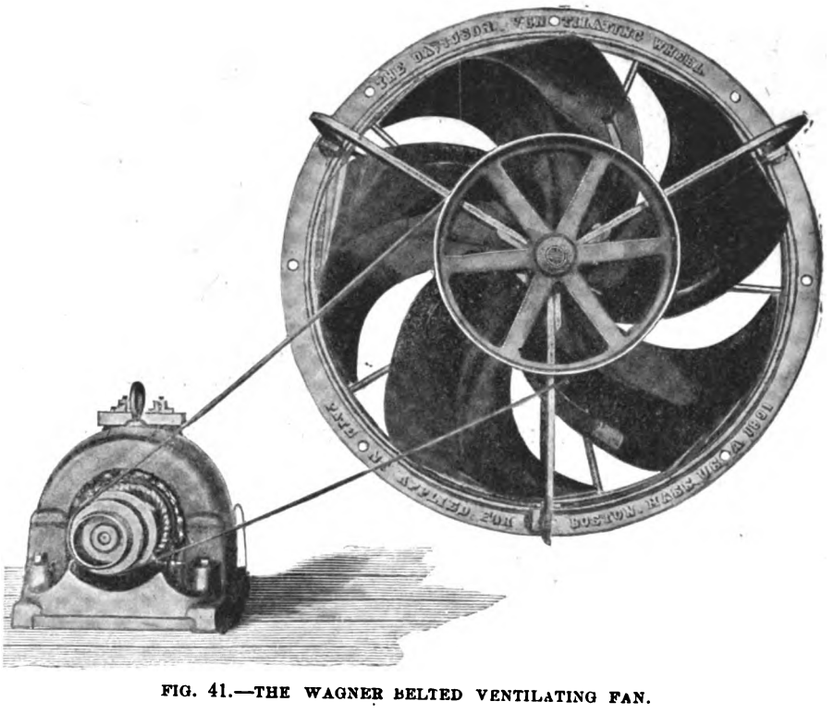


FIG. 41.—THE WAGNER BELTED VENTILATING FAN.

## THE ACCUMULATIONS OF CULM IN THE COAL REGIONS AND THEIR UTILIZATION FOR POWER PURPOSES.

BY HARRY N. GARDNER.

All travelers who have passed through the anthracite region of Pennsylvania remember the mountains of black waste piled around the coal breakers, which have possibly been looked upon as only making more unsightly an already unattractive scene, adding to the dirty appearance of a landscape that already looks as if in need of the cleansing powers of a second deluge.

These unsightly culm piles were for years looked upon almost as a curse to the region. But as the engineering and commercial eyes of the progressive nineteenth century have seen in Niagara's spray something more than picturesque grandeur, so they have seen in these heaps of waste coal screenings something more than mountains of dirt; they have looked beneath the unattractive exterior and seen the countless wheels that could be turned by these Niagaras of culm.

While these piles are looked upon as consisting of coal that is of no commercial value, the fact remains that a large percentage of many of the culm banks consists of good, heat-producing, power-generating fuel.

A quarter of a century ago it was thought to be impossible to burn fine coal, and everything that in the sifting graded smaller than chestnut was considered to be waste, and was consigned to the dump. Grates were then invented for burning pea coal, and gradually the size of commercial coal has been reduced until now there are four regular grades finer than pea.

This former distinction in the size of fuel

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that was suited for commerce resulted in many of the older culm piles throughout the entire mining region containing a large percentage of coal that would now pass into the regular channels of trade.

One such pile of culm that stands almost in the business center of Scranton, encumbering what is now valuable real estate, was purchased a few years ago for a small amount, a breaker was erected at one end of it, chain conveyors running from the breaker to the pile drag in the coal, and this old dump is being resifted. The purchasers are making a fortune out of what was thrown away as waste.

Even with the more careful screening of coal used at present and the large decrease in the percentage of waste through the reduction in the size of marketable fuel, the fact remains that millions of tons of good fuel are every year being consigned to these dumps; and, because the better grades of coal are more inclined to crush, much of this culm is, aside from its size, the best of the fuel mined. One competent authority estimates that up to 1891, in the Scranton district alone, there had been 22,000,000 tons of clean coal thrown upon these dumps, and 1,330,000 tons are still being added every year.

Another problem confronted the coal operators a few years ago. Not only was there this large waste of fuel, but to get rid of it, it was necessary to take up space which in some cases would otherwise be valuable real estate.

Of course there has always been much thought expended on the matter of finding a use for this waste. One scheme that has been for years, and still is being, tried is to compress the culm into briquettes after mixing the dust with some kind of binding material. Such a course will probably always be a failure, not because the product is inferior, for it does make the best of fuel, but because of the cost of production. In many cases, as is being done in several places besides the one referred to, it will be possible to partially solve the problem by sifting over the old dumps.

Steam and mechanical engineers have long been working at the problem from another side, with better results, by trying to build furnaces and grates that will burn the culm just as it exists in many of the heaps.

There are piles that contain so much dirt, rock and slate that their contents are practically worthless for fuel; but taking the average dump, aside from these and those others that contain enough large coal to make it pay to resift them, and it is found that culm can be successfully burned, and that it has a heat producing value of about 70 per cent of that of egg coal. But as it takes more of it to generate a given amount of steam, it costs more to handle it, and the boiler plant costs more in the first place, adding to the interest and depreciation account.

When the question arises of using this fuel at a distance from the mines, a proportion is at once found where the extra freight for the increased tonnage, cost of handling and higher fixed charges for the steam producing plant take one side, and the difference in the cost of the two kinds of fuel at the mines the other. It is found that the former soon overbalances the latter, so that culm is not an economical fuel except within a certain distance from the mines. As to the economy of using culm in the mining regions, where it costs from nothing to 35 cents per ton, and egg coal costs $2.40 per ton, there is no doubt.

The Illuminating, Heat & Power Company, of Scranton, has culm furnished for its electric light plant by the Jersey Central Railroad, which, rather than encumber valuable real estate, delivers the fuel to the door free; thus the only expense which the company has for power is the cost of firing and the interest on the plant.

The Suburban Electric Company, of the same city, which is controlled by the same company that is resifting the large dump referred to, built its plant at one end of that dump, and the fuel costs the interest and depreciation on the plant, the dragging in of the culm with a chain conveyor and firing with an automatic stoker.

This dump is shown in the photograph. The small breaker for resifting can just be seen at the lower left hand corner of the picture. The electric light plant is out of sight, back of the culm pile.

From a set of tests carried out by skillful engineers and from computations furnished by the best engineering authority, it is found that power for driving machinery can be generated in the anthracite region at a cost of $10 per h.p. per year. This estimate includes the interest, insurance, taxes and depreciation on engines, boiler plant and buildings, the cost of firing and removing the ashes, the cost of fuel, figuring the culm to cost twenty-five cents per ton, and the cost of water (the water costs more than half as much as the fuel) power to be furnished for twelve hours a day for 313 days per year. This will be seen to be as cheap as it has ever been calculated that power can be furnished from Niagara Falls.

Besides the millions of tons of culm now standing in the dumps ready to be transformed into mechanical energy, there is fuel enough every year being piled upon these culm banks, in the Scranton district alone, to generate 75,000 h. p.

For years the engineers and manufacturers of the entire world have seen in the mighty cataract a few miles from Buffalo not only picturesque grandeur unsurpassed for its kind in the world, but commercial power developing possibilities equally unsurpassed. Now this engineering dream is realized, and the commercial wheels of Buffalo are being turned by the might of Niagara Falls, over twenty miles distant.

In the development which must necessarily come to the city by the lakes, because of the inducements offered to manufacturing enterprises by the cheapness of Niagara's power, the cities over the mines should not be overlooked; nor should it be forgotten that they can offer to manufacturing industries the inducements of even cheaper power.

And should the other engineering dream be realized, and electrical transmission of energy be perfected to such an extent that power from Niagara can be economically used to drive the commercial wheels of New York City, as has frequently been suggested, it is easy to see that the cheap power that can be generated in the mining regions is over 250 miles nearer to the metropolis than are the Falls, and it will have the fixed charges against just that many miles of transmission line in its favor for running metropolitan machinery by the Niagaras of culm.



A SOURCE OF CHEAP FUEL FOR THE SUBURBAN ELECTRIC COMPANY, OF SCRANTON.

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## EFFECTS OF HIGH-PRESSURE STEAM ON ENGINE CYLINDERS.

BY F. W. ROLLER, M. E.

The numerous advantages in the line of efficiency that are gained by the use of steam at high pressures in steam engines have long been recognized, but the difficulties which became marked as the pressures approached 125 to 150 pounds, not so much on account of mechanical strength of fittings and parts as of lubrication at the high temperatures involved, seemed for a time a serious bar to further progress in that direction. Even at present it seems to be believed by a large majority of those having charge of the operation of steam machinery that markedly higher pressures are by no means commercially practicable or advisable except under special conditions, and that the old troubles of burnt-out piston and valve rod packings, and scoring of cylinders and valve seats would be sure to confront those who might attempt to employ appreciably higher values. This is well evidenced by the fact that only in rare instances are large plants designed for pressures of over 150 pounds in spite of economy and space being gained thereby, while in the large majority of cases much lower limits are assigned.

In the above connection it may be of interest to note that under that most trying of all services, namely marine work, the modern tendency is to make 250 pounds at the engine throttle a standard and even 350 pounds is being employed abroad in work of this class and giving the best of satisfaction.

The question of manufacture of fittings for these pressures was a comparatively simple engineering problem, involving, to be sure, careful testing and design, and equally careful workmanship, but nevertheless completely soluble.

The lubrication factor was, however, another affair, no oils either animal or mineral having been found that would operate continuously and satisfactorily under the high degree of heat. All proved, moreover, highly objectionable in that they coated the condenser surfaces with a non-conducting film that utterly destroyed the efficiency of this part of the plant and were equally troublesome where not positively dangerous when they reached the boilers. Plumbago, when used, in addition to being difficult to properly inject and distribute, had a cheerful habit of clogging all small passages and check valves and was also found to be unsuited.

The final solution of the difficulty has been to take the bull by the horns and simply dispense with lubricants altogether.

There seems to be a peculiar property of cast iron when employed for cylinders by virtue of which if it can once be run to a glaze without the employment of oil, it will acquire a polish far higher than is ordinarily seen and operate indefinitely without the use of lubricants, barring, of course, any introduction of foreign matter between the working faces. The action must be analogous to the increase of surface density caused by ordinary burnishing processes, and is perhaps still better exemplified by the surface hardening that takes place on the faces of the thread in the well-known screw type of elevator where the balls interposed between the screw and the threads in the anti-friction nut, rolling under great pressure between each, polish and compact their surfaces in a very similar way although not of course under such high temperature. Getting the initial glaze seems to be largely a matter of luck, as the most careful machining, cleaning and removal of burrs can hardly be relied upon to remove the almost infinitesimal chips or shoulders which start the cutting action and it takes a great deal of stoicism sometimes to refrain from starting up the lubricators when a cylinder commences to "squeal" and the pistons are traveling at a speed ordinarily considered to be, if anything, a little over the limit set by the best practice.

So satisfactory is this method of operation, however, that in the case of a large number of our torpedo boats, where 250 pounds is the standard pressure and the piston speeds run up as high as 1,400 feet per minute, the cylinder lubricators are dispensed with entirely, and the only oil that ever gets into the cylinders is introduced through the indicator piping and this only when it is known in advance that the engines will not be used for the space of twelve hours or more and that at the same time there will be no opportunity to take off the cylinder and valve chest bonnets to dry off and coat the surfaces with a thin layer of vaseline or the heaviest cylinder oil as a protection against the rapidly formed rust.

The valve stem and piston rod packings are of course subject to more severe service than the piston rings and cylinder liners as they work in whatever small amount of dust and dirt there may be flying about and moreover must be entirely steam tight. A sufficient number of metallic packing rings with a couple of turns of soft packing at the end have, however, in connection with the small amount of oil which would naturally find its way to the rods, been found to answer well here.

It has been generally considered that the moisture in the steam acted as a lubricant in the above cases, there being always, even under the best conditions, not less than 2 per cent. of this present. This seems to be disproven by the practice that has been universally adopted abroad and which will be employed on the new men-of-war contracted for by our own Government, in which, in order to get the advantage of the far smaller cylinder condensation losses following on the use of superheated steam, the boiler pressure is kept much higher than that at which the engines are to be run and reducing valves are inserted which by wire drawing, give the superheating effect desired. (The common practice is 300 pounds at the boilers and 250 pounds at the engines.)

This system has been in operation on a large scale and in a number of vessels for at least two years past with no objectionable results.

It will be noted that all the foregoing concerns engines of the vertical type. The writer is not aware of this having been worked on any scale with horizontal engines and it is possible that the weight of the piston riding on the lower surface of the cylinder would in this case render the attainment of the glaze difficult or impossible. If this should be so, however, tail rods, either open or covered by long bonnets are perfectly feasible and the marked gain in efficiency which high pressure saturated or superheated steam gives would be a large return on a trifling expenditure.

## THE WEHNELT INTERRUPTER.

BY CHARLES T. CHILD AND GEORGE T. HANCHETT.

Interrupting apparatus for the primary circuits of induction coils has received no little attention from inventors and students of late years, especially since interest in X-ray work has caused the induction coil to be the subject of much experiment. The desideratum in this form of interrupter is practically instantaneous closure and opening of the circuit, and experiments without number have been made for this purpose, most of them being with the ancient hammer-break or tooth-wheel contact in some form. With the sole exception of the liquid-contact breaks, recently patented by Mr. Tesla, there seems to have been no radical innovation in this field until Dr.

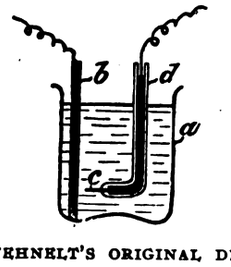



FIG. I.—WEHNELT'S ORIGINAL DRAWING

Wehnelt described, in one of the German papers, the remarkable invention which forms the subject of this article.

The drawing published with his description is reproduced in Fig. 1. The interrupter consists solely of a vessel, a, containing a plate of metal, preferably of lead b and a glass tube d having a bit of platinum wire sealed in its lower end, and filled with mercury. The cover, a, is filled with an electrolyte, preferably sulphuric acid and water in about the proportion used for accumulators. If this apparatus is connected into a circuit of sufficient power, so that the fall of potential between the two electrodes is more than about 12 volts, the well known forge-effect will take place if the metallic plate is the anode. The platinum tip c will be melted and the apparatus probably destroyed.

If, however, the connections are so made that the platinum point becomes the anode and the metallic plate the cathode, then there will be seen a yellowish glow surrounding the platinum tip, bubbles of gas will stream up from it, and the cell will emit a harsh, buzzing, definite sound, showing

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that rapid vibrations of some character are taking place in it. Dr. Wehnelt's discovery was that the current was periodically interrupted by this simple apparatus, and that the interruptions are perhaps sharper and more definite than those due to any form of mechanical interrupter. Such an

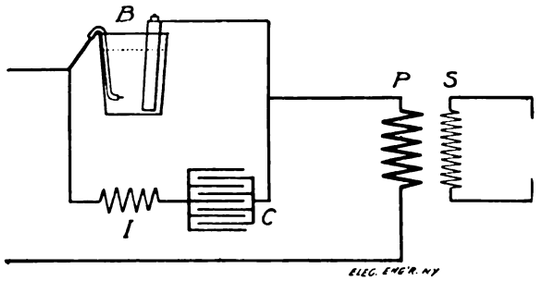



FIG. 2.—INTERRUPTER SHUNTED WITH CONDENSER AND INDUCTANCE.

apparatus connected in series with the primary of an induction coil gives surprising results. A stream of sparks of great intensity bursts from the secondary terminals, and if these are approached within a moderate distance of one another the sparks merge into a continuous arc, possessing all the qualities of the high-tension alternating arc. The effect upon vacuum-tubes is astonishingly powerful, but the production of X-rays by this means is not so satisfactory as might at first be thought, for the discharge seems to be almost purely alternating in character and not of the unidirectional sort necessary for this purpose.

The literature of this subject is doubtless destined to be large. So far, perhaps, the most important contributions to it are the results of experimental work published by Prof. Elihu Thomson in the "Electrical Engineer" of March 2, and in the "Electrical World and Electrical Engineer" of March 18, 1899. In Dr. Wehnelt's original paper the effect was noted that the frequencies of interruption increased with the voltage. The more recent work goes to show that the frequency of interruption depends upon the area of the platinum exposed, the inductance in the circuit and the voltage, and that it is important, in order to secure high frequencies of interruption, that the self-induction of the circuit should be as small as possible. This is well illustrated by bringing the secondary terminals of a coil actuated by a Wehnelt interrupter close together, so that an arc is established between them. This naturally reduces the inductance in the primary circuit and the note given out by the apparatus immediately rises in pitch. The size of the platinum determines not only the frequency of interruption, but also the amount of current that will pass under a given voltage, and interruptions, judged by the pitch of the sound given out, as frequent as 2000 per second may be had by using a platinum point of No. 24 wire about 1-16th of an inch long.

Prof. Thomson noticed that, as the frequency increases, the induction coil behaves more like a high-frequency apparatus and that if the interrupter be shunted with a condenser, as shown in Fig. 2, very brilliant high-frequency effects may be had. He also noticed that as the speed of interruption increased, the secondary discharges became more purely alternating in character.

This able experimenter has made the following tentative suggestions for an explanatory theory of the action of the interrupter: "On the attainment of a certain current density the wire becomes a veritable positive crater as in the arc, or at least the layer of electrolyte in close contact with the wire is so highly heated as to become disassociated into oxygen and hydrogen, with oxygen in excess from electrolysis. This layer insulates the wire as with a covering, stops the current, the gases reunite with explosion, casting out the excess of oxygen in bubbles, the liquid touches the wire again and the process is repeated indefinitely. This would explain why a certain current density as a limiting value must be attained at the platinum surface before the phenomenon can begin.

"If the resistance in the circuit is so great that this limiting value cannot be attained, the interruptions do not take place."

It was soon found that several of the interrupters would work perfectly well in parallel, though it is somewhat doubtful if

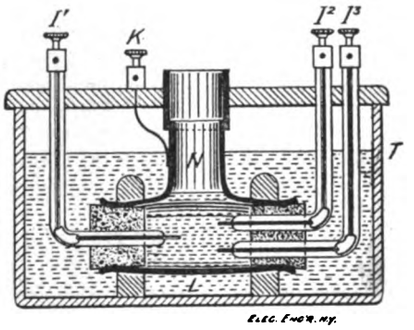



FIG. 3.—THOMSON'S ARRANGEMENT OF INTERRUPTER.

the interruptions in this case are as sharp as those produced by a single platinum point. The very simple arrangement suggested in Fig. 3 in which N is a tee of lead pipe, containing rubber stoppers through which the tubes bearing platinum points protrude, and filled with acidulated water, is a convenient form of the apparatus proposed by Professor Thomson. The outer containing vessel is filled with water for the purpose of keeping the apparatus cool. Professor Thomson found that the interrupter would work on alternating currents, provided its natural period is high enough to allow the current to rise to its critical value during one half-wave, or during one alternation. The secondary sparks obtained in this way seem to be unidirectional, and it is recommended to use a platinum foil cathode in place of the lead plate when working with alternating currents.

The inductance of the whole circuit, including the dynamo, is to be taken into consideration unless some other load, a battery, or a condenser, is also connected across the mains. If these loads are large enough the effect of the dynamo circuit inductance may be practically annulled, leaving the inductance of the coil in series with the interrupter alone to control the rate of interruption with a given surface of platinum anode. Professor Thomson speaks of the curious rise in brightness of incandescent lamps connected across the mains of the supply circuit near an interrupter when the latter was operated. This effect was due to reflection into the supply leads of high periodicity currents superposed upon the continuous currents in them.

For electric welding the interrupter has given very successful results when operated in connection with a small, open-core, welding transformer. The efficiency of transformation, even at the very high frequency arising from its use, is said to be very great. It was noted by Professor Thomson that an induction coil shunted around an interrupter, a condenser being interposed in the circuit, gave excellent results. The use of this apparatus furnishes a means for demonstrating many alternating-current phenomena where an alternating source of supply is not available. A coil of comparatively small wire, wound upon an iron-wire core, and an interrupter for small currents are all the apparatus needed. It is, of course, necessary that the cores for the coil used with the interrupter or other high frequency apparatus should be of the open magnetic circuit type.

Experimental work recently conducted by the writers demonstrated very clearly that the form of interrupter illustrated by Dr. Wehnelt can be vastly improved in practice. The difficulties surrounding its working are very great when it is attempted to force large currents through the apparatus. The platinum point must necessarily conduct the whole current and, while its rate of expansion is practically the same as that of glass, when it is rapidly heated by large currents its expansion frequently cracks the glass tube and spoils the apparatus. Further than this, the thin thread of mercury in a narrow glass tube, being heated by the current and by conduction from the platinum point, often becomes so hot as to volatilize, thus forming

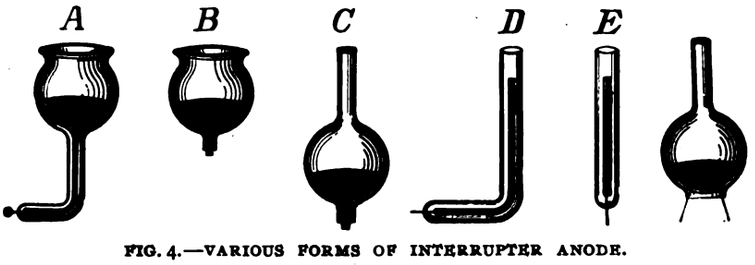



FIG. 4.—VARIOUS FORMS OF INTERRUPTER ANODE.

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an arc with practically explosive action, which either bursts the tube or throws out the mercury. The function of the mercury is not only to conduct current to the platinum point, but also to keep it cool by conducting heat away from it. This is best accomplished when the body of mercury is as large as convenient. The forms of tubes shown in Fig. 4 illustrate some that were tried by the writers, the best results having been obtained from those in which the points projected vertically down into the electrolyte and in which the body of mercury is relatively large.

If it is attempted to force too much current through the interrupter, the apparatus will work for an instant and suddenly stop. The current seems to be permanently broken, as its value falls to a scarcely measureable amount, while small bubbles stream off from the juncture of the platinum point and glass tube. If the strain of a moderately high voltage is kept upon the apparatus when it is in this condition a yellowish glow is noticed, apparently creeping back along the surface of the platinum wire through the glass, as if the current were seeking to enlarge the area of contact or actually to burst through the insulating sheath of glass. If this is allowed to go too far, rupture of the tube results. If the current is turned off while the apparatus is in this condition, a curious sucking sound is heard and the apparatus is instantly ready to work again and repeat the same cycle of operations.

In operation, the acid bath rapidly becomes very hot and, when its temperature reaches a point near boiling, the action of the interrupter ceases. For this reason it is well to make up the instrument with a water jacket in order to keep its temperature as low as possible. Noticing the rapid heating of the acid, the writers endeavored to find what proportion of the total energy supplied to the circuit was dissipated in it, and were surprised to find that apparently over 90 per cent. of the total fall of potential took place between the terminals of the interrupter itself. While these measurements were made with apparatus not suited for this work, they are probably not inaccurate, because the intense heating of the electrolyte shows that much energy is wasted in it. A very curious phenomenon was noticed when the connections were made, as shown in Fig. 5, two induction coils being used, one in series with the interrupter and the other shunted around it through a resistance composed of incandescent lamps. Both coils worked violently and, when the interrupter was in the static condition mentioned above, the lamps in the shunt circuit glowed at about normal c.p. The instant the interrupter operated a sudden brightening of the lamps was noticed, apparently corresponding to a voltage nearly double that previously present. This effect is doubtless due to some resonant action in the circuit, or to the superposition of harmonics of very high frequencies upon the circuit, giving rise to some of the extraordinary effects previously described by Professor Thomson and others.

The field for usefulness of the Wehnelt interrupter is very large. While it is highly inefficient, in that it wastes much current, still it enables the operation of induction coils directly from electric supply mains without the use of condensers or shunt resistances, and furnishes the experimenter with a reliable and satisfactory interrupter which he can make in a few minutes himself at a trifling cost. It also provides a ready source of alternating currents of high frequencies, their periodicity being intermediate between those from the oscillatory discharge of condensers and those of commercial circuits, both of which have been of late so fully studied. On this account it will be of great interest, because there has not yet been much attention paid to phenomena produced by currents of intermediate frequencies. It also provides a simple and convenient source of alternating current for demonstration purposes. It is evidently yet too soon even to discuss the commercial possibilities of the apparatus.

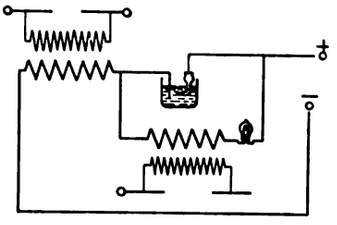


FIG. 5.—DIAGRAM OF SERIES AND SHUNT CONNECTIONS.

A word of warning must be spoken to experimenters with this apparatus. It should always be made up in a vessel provided with a cover or in such a way that it can be put out of harm's way, because there is an energetic spattering of acid drops and dissemination in the air of a fine liquid acid spray during the action of the interrupter. Induction coils of the ordinary type will probably be instantly punctured when attached to it, and only thoroughly insulated coils, or those having an oil insulation, should be used with it. Finally, the current used is generally so large that the secondary possess great energy, and much care should be used to avoid all danger of a shock from it, which, in the case of a large coil, would most probably be fatal.

## THE CANDLE-POWER OF ARC AND INCANDESCENT LAMPS.

### PHOTOMETRIC LIGHT STANDARDS.

BY PROF. WILBUR M. STINE.

The Improved English Candle.—Though all forms of candles have been shown by investigators to be unsuited for light standards, there are those who still continue a preference for them. Probably aware of the shortcomings of the candle they have scarcely more confidence in any of the substitutes which have been offered, even looking upon the Hefner lamp as an undemonstrated superior to the candle. In this belief recent attempts have been made to improve the English candle, and amongst such results are certain specifications announced in 1894.* A standard method is stated for obtaining the melting point of the spermaceti, which, when sufficiently pure should melt at 112 degrees to 115 degrees Centigrade. A point is also made of thorough cleansing of the wick to remove grease and mineral matter by immersion in ammonia followed by a second immersion in a dilute solution of sulphuric acid, and a final washing in pure water to remove all traces of the chemicals.

Certain Requirements for a Light Standard.—Before discussing the more scientific light standards it becomes necessary to formulate the conditions under which they will be estimated. With one exception these are readily understood. The excepted requirement refers to the inherent difficulty in all photometric work—that it is impossible to state an immaterial sensation in terms of matter and energy. Sights are psychological events, while standard lights are wholly physical phenomena. Then aside from all chemical and physical problems involved in the production of a standard for illuminating power, there is lacking even a partial agreement over what shall be considered as normal light. It is scarcely profitable to expand the discussion on this point, but recognizing that the color of the candle flame is unpleasantly red and that of the electric arc is usually too blue there must be an intermediate color of light which may be taken as normal for the eye.

A standard of light should be:—

(1) Normally white in color;

(2) Simple in mechanical construction;

(3) Not liable to especial deterioriation of any part;

(4) Renewable without change of light value;

(5) Constant in operation;

(6) Reproducable with accuracy.

The Methven Screen.—This standard consists of an argand gas flame burning at the prescribed height of three inches and surrounded by a straight glass chimney of the usual diameter for such flames. Immediately on the outside of the chimney a metallic shade or screen is attached, pierced by a slit of such dimensions that the light passing through it is supposed to be equivalent to two candles.

It is well to call attention to a fact frequently overlooked in the use of such standards as require a screen. The distance from such a light source to the photometer screen is measured from the slit and not from the center of the flame.

The Methven screen possesses the merit of great mechanical simplicity. But all manner of gas flames vary in light giving strength according to the quality of the gas burned and it is practically impossible to obtain gas of sufficiently known and controllable quality to insure uniformity of the light-emitting power of the flame. It is very singular, indeed, that the supposed principle of the Methven screen—that by taking a definite area of a gas flame of uncertainly variable illuminating power a constant light could be obtained—was not immediately seen to be fallacious, and that

*E. G. Love, in the "American Gas Lighting Journal," March 5, 1894, page 326.

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it should have ever received any acceptance.

The use of a glass chimney on a light standard is to be condemned, since the portion of the light absorbed by the chimney is variable and largely dependent upon the cleanliness of the surface of the glass; and by reflection from the inner walls of the chimney an error is introduced which varies in its influence with the change of the distance of the light from the photometer screen. The illuminating power of the Methven screen for any given quality of gas also varies with the humidity and the pressure of the atmosphere.

Numerous unsuccessful attempts have been made to carburet the gas burned, but without accomplishing the desired constancy of this light. The Methven screen is, however, useful as a secondary standard and is still employed at some incandescent lamp factories even as a primary standard.

The Pentane Lamp.—The Harcourt pentane standard has not been widely used in this country, though it has not lacked its stanch advocates. In its later form it consists of a lamp with a reservoir for holding the pentane with an appropriate wick and tube. The flame burns inside a metal chimney with an appropriate opening in the center and a gage for indicating the flame height. The combustible being so readily volatilized, the wick does not char, and alter the rate of the capillary feed of the combustible to the flame.

The pentane required for this lamp is a refined distillate obtained from gasoline. Pure pentane is a hydrocarbon of the formula, $C_5 H_{12}$. The liquid obtainable under this name consists of this substance and several similar and related compounds in solution. Aside from a few laboratory samples there is probably no pure pentane to be had. Here is a combustible eminently suited for a standard light, since it is chemically simple and burns with a clear, white flame, but not to be obtained commercially in sufficient purity. Though a committee of the British Association reported in 1888 that "the pentane standard of Mr. Vernon Harcourt is reliable and convenient, and fulfills all the conditions required in the adoption of a standard of light," their judgment has not been confirmed by subsequent practice with the lamp owing very largely to the uncertain quality of the combustible.

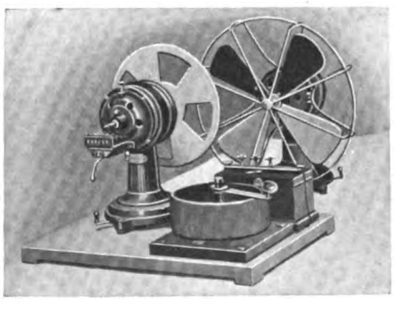
The Arc-Standard Light.—In 1878 Abney discovered that the intrinsic brightness—the amount of light emitted from unit area of a luminous surface, as the square millimeter of the crater surface of the arc—was constant for any one carbon independent of the power absorbed in the arc. Later investigators have fully confirmed this fact for such wide variations of absorbed power as 500 and 34,000 watts. This is explained by supposing that carbon reaches its boiling point near 3,500 degrees Centigrade, the approximately determined temperature of the positive crater. In the same manner that the temperature of water boiling at a definite atmospheric pressure remains constant during evaporation, so in the electric arc, the power absorbed heating the carbon to its boiling temperature, thus volatilizing it, the temperature would remain constant and the quality of the light emitted and the intrinsic brightness of the source, both being functions of the temperature, should also remain constant. Further, just as the temperature of water will remain constant at the boiling point whether evaporated slowly or very rapidly, the temperature of the positive crater of the carbon should remain constant independently of the current flowing or of the length of the arc.

The attempt has been made by Blondel, Violle, Swinburne and others to utilize these facts in realizing an arc standard of light. In this case a suitable screen with a circular opening of approximately one millimeter diameter is placed in front of the crater, and the amount of light thus obtained should be definite in quality and quantity. Yet no two investigators have obtained comparable results, nor has any one investigator shown invariable results with different qualities of carbon, or in fact with different carbons. If it is permissible to designate the carbon in such a case as the combustible it is seen that this attempted standard of light has failed where all other standards have failed with the exception of the Hefner lamp, and in this case the failure is due to the influence of the quality and character of the carbon on the quality and quantity of the light emitted, or what, perhaps, is the same thing, on the vaporization-temperature of carbon.

It has been frequently pointed out by the writer and others that hard carbon will, for given power absorbed in the arc, emit less light and a light bluer in tinge than that obtained from soft carbons under similar conditions.

## Among our Foreign Contemporaries

**Measuring the Speed of Small Motors.**—In testing very small motors, difficulties arise in measuring the speed because the power is so small that if the usual speed counter is applied so much power will be absorbed that the speed necessarily falls. A very simple method of measuring the speed accurately, although it involves the use of a second motor, is described in a recent paper by Dr. Benischke in the "Elektrotechnische Zeitschrift." It is what is technically called a stroboscopic method, but is much simpler than some might infer from the name. The motor to be tested is provided with a fan or with a disc with



A SIMPLE STROBOSCOPE.

black marks or holes; the other is similarly provided with a disc with holes in it, and the two are placed nearly opposite to each other, as shown in the adjoining figure, the second motor being arranged with a suitable resistance in series so that its speed may be adjusted. The two motors are then run and the vanes of the fan are viewed through the holes in the disc; when the two speeds are equal the vanes of the fan thus seen through those holes will seem to stand still, provided the number of vanes is equal to the number of holes; for any other relation between them the necessary correction factor can readily be made. The speed of the second motor is therefore adjusted until these vanes appear to stand still, and at that moment the speed is measured by any convenient speed counter or other indicating device, as, for instance, a bicycle cyclometer, which, however, must first be calibrated for that motor. Before the speeds are exactly alike the vanes will appear to move slowly in one direction or the other.

Another application of the same stroboscopic principle is also described in that paper and can be applied to measuring the frequency of an alternating current. A bottle of water is placed upon a stand which is slightly flexible and is attached to the armature of an electromagnet through which the alternating current passes, the bottle being then vibrated slightly exactly as many times per second as the frequency of the current. By any convenient means such as a siphon or an opening near the bottom of the bottle, a small stream of water is allowed to pass out so that it breaks into drops, the number of drops being then equal to the number of oscillations. This stream of drops is viewed through the holes in the disc of the motor as in the test above described, and when the number of holes passing per second is equal to the number of drops, the latter will appear to be standing still; by measuring the speed of the motor and multiplying it by the number of holes in the disc the frequency of the current is easily calculated. An interesting observation is that when the speed is not exactly right, the drops will appear to move upward and pass into the bottle, a rather curious delusion.

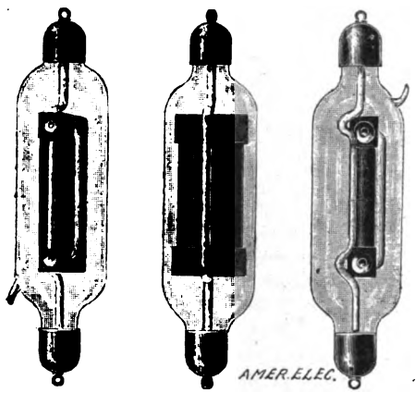
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**Comparing Different Automobiles with Each Other.**—Unless all automobiles which engage in competitive trials are very nearly alike, a comparison becomes difficult, as various factors should be taken into consideration; it does not necessarily follow that the fastest one is the best. An

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interesting method of comparing them, and one which seems quite rational, was suggested by Chauveaux and was mentioned in a recent lecture reprinted in an Austrian electrical journal. He assumes that a true measure of the practical effectiveness depends on the actual power of the motor, the speed of the vehicle and the number of persons carried. Such a factor is determined by dividing the h.p. of the motors by the product of the number of persons carried and the average distance traveled per hour; the smaller the factor thus calculated the better the automobile. This factor represents simply the power required per passenger and mile, also involving the speed, as the factor will be smaller the greater the speed. It is interesting to note that when applied to the automobiles in the recent test between Marseilles and Nice in France, the one that received the first prize would have been fifth, while an obscure vehicle which received no prize would have gotten the first one, as the factor for it was only about a quarter of the one that got the first prize.

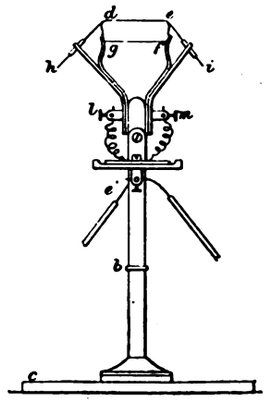
**New Vacuum Telephone.**—There are a number of reasons why a microphone can be expected to act better if the carbons are enclosed in a vacuum. One of these is that relatively strong currents can then be used without such a risk of injuring the delicate contacts; moreover it is then also independent of atmospheric moisture and other external causes of failure. Such a microphone has recently been put on the market in England and is known as the Kilduchevsky telephone transmitter, although in this country it would probably be called simply a vacuum microphone. A very brief illustrated description is given in the London "Electric Review," the illustration from which is reproduced in




TELEPHONE TRANSMITTERS IN VACUO.

the adjoining cuts. Unfortunately they are not quite clear, but will give a general idea of the arrangement. As will be seen the leading-in wires are made thick enough to support the microphone. The brief description states that the current may be increased to any extent without liability of the oxidization of the contacts and that no packing can occur. The instrument is said to have been successfully tested in Russia over lines 2,000 miles long, a statement which requires some further modification, as the transmission depends on other things besides the length of the line; nevertheless the distance seems very great and speaks well for the instrument. In England it has been tested on an artificial cable of an equivalent length of about 200 miles, having a resistance of nearly 600 ohms and a static capacity of nearly 60 microfarads, thus giving a "K R" equal to nearly 36,000, this quantity being the product of the resistance and the capacity as its symbol indicates, and is considered by some to be a measure of the limiting conditions under which telephony is possible, a statement, however, which has been doubted by others as the value of the "K R," which was at one time considered to be the limit, has been greatly exceeded on the lines in this country.

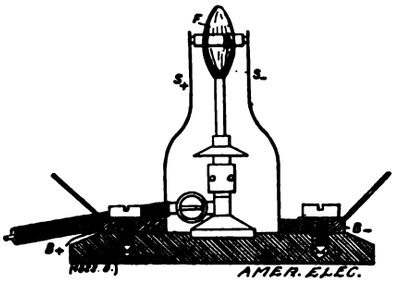
**The Nernst Lamp.**—As with most new inventions, the first thing that those who did not invent it do, is to look up anticipations, and the Nernst lamp is no exception. The English papers more in particular have unearthed some early descriptions of lamps which must be admitted to be to a great extent close anticipations, at least in the general principles. While, no doubt, the future manufacturers of this interesting and much talked of lamp will develop many patentable improvements, yet the lamp in its most primitive form has been clearly anticipated and can be used by any one. It seems that the lamp is so easily made that almost any skillful mechanic can make one for himself, and wherever there is no great




AN IMPROVEMENT OF THE JABLOCHKOFF CANDLE

objection to spending a few moments in heating it with a Bunsen flame, the lamp may be used to advantage as it is so very much more economical than the usual incandescent lamp. One of the earlier forms, though not the earliest, is shown in the first of the adjoining illustrations, which was published in the London "Engineering" Oct. 14, 1881, as an improvement on the original Jablochkoff lamp. It will be seen that the rod of refractory material is held between two clamps which lead the current through it. The intention seems to have been to light it by means of what might be called a match, that is, the wire h d e i, which is connected with the same terminals and presumably was heated first by the current which soon melted it off, but in doing so heated the refractory material until it began to conduct, after which it gradually increased in conductance until it took the full current. It is said that this conducting match for lighting it was a carbonaceous mixture and that the arc resulting from its rupture would heat the non-conductor until it conducted. Wherever a Bunsen burner is handy, as is the case in many laboratories, probably this form of heating would be the simplest. The second illustration, by way of comparison, shows the Nernst lamp as illustrated in one of his first patents.

Mr. Fonta, in the London "Electrical Review," makes the statement that after experimenting with the Nernst lamp for some time and obtaining satisfactory results, he is now able to state confidently that lamps of any c.p. and voltage, and with an efficiency of 1.5 per candle, may be made. This efficiency is about what is claimed by others and is probably not questioned, but the fact that they can be made for any c.p. and voltage is of interest. But the most interesting statement that he makes is that no preliminary heating is required. Unfortunately, he does not describe how he gets over that difficulty nor does he give any further information. No




ONE OF THE NERNST DRAWINGS.

having heard of that writer before, we cannot say whether he is an authority or not.

In the later Nernst patents, it is stated that by adding certain materials in making the little rod, it is possible to start the lamp with only the heat from a match.

Many opinions have been expressed on the probable future of the Nernst lamp, and most of them seem to agree that while it may have very good prospects, yet at present it is only in the experimental stage.

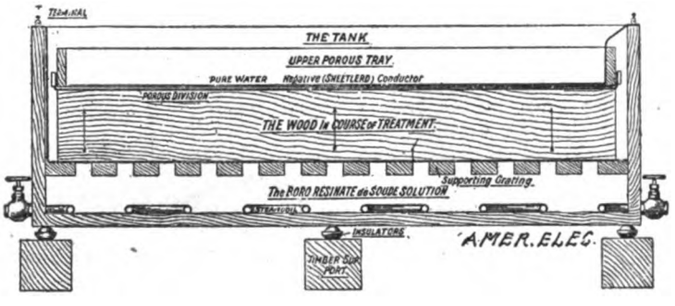
**Best Strength of Acid for an Accumulator.**—The question is often asked whether or not an accumulator would be improved if the acid were stronger, and the reason that this is difficult to answer is that a difference in concentration has various effects, the choice of the best concentration being therefore by no means a simple one. Some time ago Mr. Jumau found that the capacity of an accumulator varied with the concentration of the acid, but that the variation was not a constant one as it increased at first with the concentration, then reached a maximum and then diminished again for greater concentrations, thus showing that there is a certain strength of acid for which the capacity was greatest. In order to find whether this was true for all rates of discharge he made some very elaborate experiments which are described in "L'Eclairage Electrique," but with the unfortu-

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nate result that for different rapidities of discharge this best concentration was quite different, as it increased with the rate of discharge and soon got above 35° Baumé, which is about the practical limit as sulphating of the negative plate is apt to occur with greater concentrations. He also continued the investigations to find whether this best concentration was the same for the positive plates as for the negatives and found that for the positive plates the acid should be more concentrated to give the best capacity, and for the negatives less so, but in both it varied. Theoretically, therefore, the best conditions are obtained with different concentrations of acid which can only be had with the aid of a porous cup and that is not practical; moreover, there is a certain density which is the best for each rate of discharge. It is, therefore, possible to give only a general rule concerning the concentration, namely, that it should be greater, the greater the rate or rapidity of discharge.

**A Method of Measuring Inductance.**—One of the most unsatisfactory of all electrical measurements is to determine inductances, which are analogous to the moment of inertia in mechanics. A method which is said to be satisfactory was devised some time ago by Prof. Puluj, an Austrian physicist, and was recently described in the "Wiedemann's Annalen." In this method one inductance is compared with another, therefore one of them must be known. They are connected in two circuits in parallel and an alternating current passed through them, resistances in series with each being varied until the currents in both branches are in phase with each other, and when this point is reached, the inductances are directly proportional to the resistances in those circuits; knowing these resistances and one of the inductances the other is found by calculation. But this requires an instrument to indicate when the phases are alike. This may be made of two small coils at right angles, mounted so that they can be rotated; suspended in the middle of these is an aluminium or copper rod having a pointer. The two currents are passed through these two coils, and when they are in phase no deflection of the copper rod will be produced.

**Seasoning Timber Electrically.**—An interesting application of the electrical current for the somewhat odd purpose of seasoning timber is said to be used with success in Europe, and is about to be introduced into England. The general principle involved is that a current is passed through the wood across the fibres, while the wood is partially immersed in a preservative liquid, the action of the current being apparently to drive out the sap and replace it with the preserving liquid, which is a 10 per cent solution of borax containing 5 per cent of resin and 5 per cent of carbonate of soda. The adjoining illustration of the tank was published in "Lightning," an English paper, and will explain itself. It will be seen that the timber is placed on the lower electrode, which is the positive pole, the negative pole being a sheet of lead lying on the top of the wood, with a thin layer of felt intervening. The whole solution is kept warm at about 145 deg. F., and reaches within a few inches of the top of the wood at the start, being gradually lowered as the process is completed. It is said that a current of 600 amperes at 110 volts is used, but for what sizes of the wood to be dried, is, unfortunately, not stated. The sap which is displaced rises to the top of the solution. The process is said to require from 5 to 8 hours, depending on the condition of the wood, green wood being easier to treat than that which is dry. After treatment the wood is dried either in the open air or in a drying chamber. One report states that the current is 18 amperes per cu. ft. per hour, which at two cents per k.w. hour (a rather low figure), represents 0.04 cents per cu. ft. Another statement says that it takes 600 watts per cu.m. of wood. Still another says that one kilowatt hour per cu.m. is required.




CROSS SECTION OF TIMBER SEASONING VAT.

One of the peculiar results is that wood which is otherwise useless, like maritime pine, which never dries in the open air, can be perfectly seasoned and dried in this way. The treated wood is also said to be impervious to dampness and not liable to be attacked by insects.

**Measuring Condenser Discharges.**—It is sometimes of interest to measure the quantity of electricity contained in the discharge of a condenser such as a Leyden jar, or in general, the quantity of electricity in spark discharges, but such a measurement generally involves difficulties. What seems to be a simple and effective method was recently described by Prof. Cardani, an Italian physicist, in the "Nuovo Cimento." It is based on what the chemists call a volumetric analysis. A normal solution is prepared of sodium chloride, otherwise known as common kitchen salt, diluted 200 times. Electrodes are placed into this and it is put in circuit with the spark discharge so that the same quantity of electricity which is contained in the spark will pass through this solution and will decompose it to an extent which is exactly proportional to the quantity of electricity in the discharge. As this quantity is necessarily very small, it is determined by first coloring this solution with phtaleine of phenol, which gives a red color, and sufficient oxalic acid is then added to make it a pale rose. A sample of the original solution is kept to preserve its color for comparison. After passing a certain number of discharges through the solution, as many as possible, if they are small, the color of the liquid will have been changed by the electrolysis. Oxalic acid is then added to the electrolyzed solution until its color is the same as that of the sample; the quantity of oxalic acid thus added is measured, and from it the amount of sodium which has been liberated is calculated. As such a calculation may require the assistance of a chemist, a simpler way might be to make a second experiment with a very small, steady current, passing it through a similar liquid until the color is the same as that produced by the spark discharges; the quantity of electricity in this steady current is easily measured, either with a galvanometer or by calculation from the voltage and the resistance, provided the resistance of the liquid can be neglected. In these measurements, extremely small quantities are involved, as a spark, although very bright, really represents an extremely small quantity of electricity.

**A New Primary Battery for Power Purposes.**—A young Frenchman has devised a new form of primary battery in which the depolarization, which is generally that which limits the power output of a battery, is very energetic, and the battery is therefore adapted for strong currents; it is even claimed that it has been applied with success to automobiles in Paris. As a rule a primary battery contains much more energy per pound than an accumulator, and where weight is of so much importance as with automobiles, it is not necessarily absurd to consider it possible to use primary batteries for such vehicles; if a primary battery is cheap and easily handled, there might be a possible field for it for such vehicles. The distinctive feature of this new one is the use of the element vanadin or its salts or oxides. The battery is a two-fluid cell, with a porous cup; one compartment contains a solution of chloride of sodium, that is, common kitchen salt, in the proportion of 20 to 100 of water, and in this is placed the amalgamated zinc electrode. The other compartment contains a carbon plate surrounded, like in the Leclanche cell, with fragments of carbon and granulated manganese oxide, but to this is added some fused vanadin acid, together with some sulphuric, vanadic and hydrochloric acid, or this solution may be a mixture of chloride of potassium, with about 5 per cent of oxy-chloride of vanadin. The other compartment may also contain some

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sulphuric acid. An addition of about 10 per cent of bichromate of potash in the compartment containing the carbon is said to increase the action. Such a cell is said to give 13 amperes at 2 volts and to be much more steady than the usual bichromate or Bunsen cells; unfortunately, however, the size of the cell is not given in the brief description in the "Electrotechniker," a Viennese journal, from which this description is taken. The description, too, is not as clear as might be desired.

**Cost of Lighting at Reduced Voltages.**—It is well known that when the voltage at the terminals of an incandescent lamp falls, there is much less light given out in proportion to the drop in voltage, but there is also less current used, and the question therefore arises, How much more will a consumer be paying for the light when the meter registers in k. w. hours. This is discussed briefly in London "Electrical Engineer," March 3, assuming the voltage to fall from 230 to 200. One contributor gives some tables showing how greatly the watts per candle diminish with an increase of voltage, and he finds that for a drop of about 10 per cent in the volts there is a drop in the efficiency of conversion of electricity into light of over 30 per cent; for still larger drops the efficiency of conversion falls much more rapidly. From this table an illumination of 144 candles is obtained by nine lamps consuming 756 watts when the voltage is 110, while at 100 volts there would have to be 16 lamps, taking 1104 watts. Another contributor shows that a drop of 12 to 13 per cent in the meter bill would correspond to a decrease of light of about 40 per cent, showing how very much more the consumer is paying for the light at the reduced voltage. Although the general fact that the light is more expensive at the reduced voltages is well known, the actual figures above given may be of some interest. Strictly speaking, an energy much used for lighting alone, should diminish in its reading in proportion to about the sixth power of the voltage.

**A Free Wiring System in England.**—A somewhat unusual system of what in England is improperly called "free" wiring, is used at the small station in the borough of Wycombe, as appears from a recent description in the London electrical journals. The company is by the franchise compelled to wire the premises of any consumer free of initial charge. Payment for it is then made at the rate of about eighteen cents per lamp per quarter until the cost of the wiring is worked off in this way, no interest being allowed on the cost price. The houses in that town are mostly small, and it is thought that this method will induce many of the occupants to adopt the electric light. Another innovation is that the company hire out arc lamps and motors at low rates to encourage those who cannot afford to buy them.

**Large Proposed Transmission Plant.**—According to the French journal, "L'Energie Electrique," a company has been formed to carry out what will be the largest transmission plant in Europe, while the distance of transmission is one of the greatest in the world. It is intended to transmit 3000 h.p., generated by a fall of 500 ft. of the River Loue, to a distance of 72 miles to the city of Dijon and the surrounding country in France, where the watch industry is flourishing. The total cost of the plant is estimated at a little over $1,000,000 and the cost of operation at $28 per h.p. per year, assuming it to be used fifteen hours per day.

**Induction of One Steady Current by Another.**—It is generally stated in text books that a steady current will not induce another current in a neighboring wire and that such induction takes place only when the currents vary or alternate. An interesting experiment described by Mr. Chabot in the "Philosophical Magazine," however, shows the conditions under which a perfectly steady current will induce another steady current in a neighboring circuit. As is well known, Ampere has shown that a current in a circuit will make a neighboring permanent magnet rotate about its axis, and it was shown by Farady that the rotation of a magnet about its axis will induce a steady current. Mr. Chabot has now combined these two, as shown in the adjoining figure, thus inducing a steady current by another through the medium of

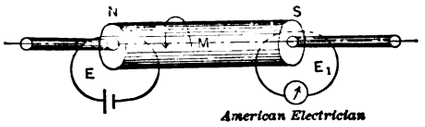



DIAGRAM SHOWING INDUCTION OF ONE STEADY CURRENT BY ANOTHER.

a revolving magnet. Let E be the first circuit, $E_1$ the second and M a permanent magnet capable of revolving about its axis over these two circuits. If a steady current passes through the first loop and the magnet be held so that it cannot revolve, a galvanometer in the second circuit will show no current, but the moment the magnet is allowed to rotate a steady current will be induced in the second circuit.

**How an Electric Spark is Produced.**—Numerous experiments have shown that an electric spark through the air prefers to follow the path of a previous spark. It appears that the first spark breaks a path through the air, which then becomes a tolerably good conductor, and any spark following the first one very quickly, will prefer to pass through this path. For this reason what appears to be only a single spark is often really a rapid succession through the same path. Some experiments were recently made by a German named Walter and described in the "Wiedemann's Annalen," in which he photographed sparks from induction coils, using plates in rapid motion, so as to separate the images of rapidly succeeding sparks. He found that a large spark was followed at very rapid but equal intervals of time by less brilliant ones, all in the same direction. But one of the results of special interest was that when the make and break was first started, only a brush discharge was produced, but these thin discharges became longer and longer at every successive break of the primary, growing, so to speak, toward the other terminal, and after having reached that terminal a stream of normal sparks followed. It thus showed how the first fine discharges bored holes, as it were, through the air before the spark discharges could pass.

**Interesting Coherer Experiment.**—The noted English physicist, Dr. Oliver Lodge, recently gave a lecture on coherers, on which subject he is probably one of the best authorities, and among other things showed the following striking result: He arranged two soap bubbles side by side, so that they were almost in contact. An electrical "splash" in the ether was then produced in the neighborhood and the effect on the two bubbles was that they came together and united, forming one large one. This experiment shows that there was some other action besides the mechanical action of bringing the bubbles together, as those who have experimented with soap bubbles will know, that two bubbles can be pressed together quite hard without uniting, and they will not join when merely brought in contact, except if the contact point is the bottom of one bubble, which always contains a drop of the liquid. In another experiment he illustrated the cohesion of metallic filings when they are influenced by Hertzian waves. On the flattened top of a brass ball some filings are placed, and then by means of a vertical wire these filings could be pulled up in a chain just as though they were magnetic.

**Multiple Terminal Connections.**—For making a number of connections with one source in laboratory work, a trough of mercury is often used, the wires being dipped into it. An improvement on this is known as the Carlin tube, a description of which was recently given in a paper by Mr. Dessauer read before a South African society. It consists of a half inch iron horizontal pipe which is plugged up at the ends and filled with mercury. It has holes drilled in through the top, the number of which correspond to the number of connections which are to be made, the size of the holes depending on the size of the wire to be used, suitable connections being also made with the pipe or mercury and the source of the current. Among the advantages of this over the ordinary mercury trough are that there is less loss of voltage, it being only 0.3 per cent for an 8-ft. tube with fifty-two connections as compared with 18.4 per cent with the ordinary trough, presumably meaning that the same amount of mercury was used. The mercury does not become oxidized or heated, and there is no danger of spilling and less loss by evaporation.

**Carbolite, A Substitute for Calcium Carbide.**—Notwithstanding the fact that the production of the carbide of calcium seems to be greater than the apparent demand, a German named Hartenstein recently patented a method of producing what he calls carbolite, a substance which is produced from the blast furnace slag as it comes

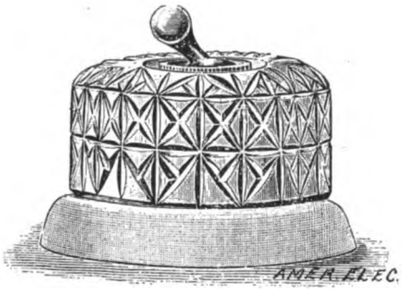
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from the furnace and is therefore a bi-product, the value of which he considers is so great that he goes so far as to say that the pig iron would then be considered a bi-product, which if true, though not likely, would be of considerable interest to iron men. The slag as it comes from the furnace is mixed with pulverized carbon in some form, such as coke, with the aid of a blast in a suitable vessel such as the converters used in making steel. This molten mixture is then brought in contact with carbon bars which are heated to the necessary temperature to produce the carbides, by means of an electric current passed through them. "Kuhlow's Review," which publishes a description of this, comments on it unfavorably. In the first place such slags contain only about 50 per cent of lime, which would make rather a poor carbide for producing acetylene. Moreover, carborundum would be likely to be formed also and this gives off no gas. There would also be some aluminum carbide which evolves methane, a gas much less luminous than acetylene. Besides these there would be the impurity of the iron carbide, so that it is not likely that the material would be a good substitute for the calcium carbide. Moreover, these impurities all require an electric current to produce them, and the process cannot therefore be said to be very economical.

**A Method of Restoring Fogged Photographic Plates.**—Now that it is becoming possible to manufacture that very valuable gas, ozone, by electrical means and at reasonable cost, the uses of it are increasing. Quite an odd application of ozone is described by Mr. Andreoli, one of the leading champions of this gas in the London "Electrical Review." He repeated an experiment suggested some years ago which shows that a photographic plate which has been exposed to the light, may be regenerated, as it were, by subjecting it to the action of ozone, after which an image can be taken on it just like on a new plate. Moreover a plate on which an image has been taken but not developed can be restored to its original condition by submitting it to the action of ozone; it may then be used over again for another image. He made experiments by covering half of a plate and exposing the other half to sunlight, then treating it with ozone and taking an image on the whole plate, that is, on the exposed side as well as on the unexposed. A Roentgen ray picture taken on the whole plate was visible just as though the silver compounds had not been acted on by the light. He suggests using the method for restoring fogged plates to their original sensitiveness. It was also suggested that ventilation by ozone may prove beneficial in works where photographic plates are manufactured, by removing many causes of reduction of the silver salt which fogs the films. Some reproductions of photographs on restored films are promised in a subsequent issue of that journal.

**Printing Without Ink by Electricty.**—process of some interest was recently shown in London in which an electric current was used for printing from type without the use of any ink. A very brief description is given in "L'Electricien." It seems that the paper is first subjected to a chemical treatment in which it absorbs a certain chemical, the name of which unfortunately is not given; but it is one which will turn jet black when a current passes through the paper, due to an electrolytic effect. The paper passes over the type and while in contact with it a current flows through it into the type; wherever the paper is in contact with the face of the type, electrolysis is produced and the paper is colored black. No further information is given, except that the process has already been perfected to a sufficient extent to give interesting practical results. As the ink is not a very objectionable feature in the process of printing it is not apparent wherein the great advantage lies in this process, although it appears to be new and interesting.

**A Luminous Switch.**—An interesting form of switch, although its principle is not new, is described in the London "Electrical Review." The idea is to have the switch faintly luminous in the dark, so that it can be more readily found when it is looked for in a dark room, an idea which has already been frequently applied to matchsafes and other similar objects which are often looked for in the dark. The switch is shown in the adjoining illustration and is of the usual kind of tumbler




A LUMINOUS SWITCH.

switch, but the cover is of glass, ornamented so as to imitate cut glass, and it is coated internally with a luminous paint which absorbs the daylight, or artificial light, and which in the dark shows a phosphorescent glow, enabling the switch to be easily found.

**Amalgamating Zinc Plates for Batteries.**—The following formula s given in the "Elektrotechnische Zeitschrift" and is claimed to give good results. A saturated solution is prepared of the neutral sulphate of mercury to which a quantity of sulphuric acid is added, sufficient to make the solution complete. This is then mixed with oxalic acid until a greyish mass is obtained, having a consistency of cream, and a little salammoniac is then added. The zincs are rubbed briskly with this paste and if not to be used at once they should be well dried. It is claimed that with this method of amalgamation the zincs resist the acids much better than when the usual method is used.

**A Solder for Aluminium.**—According to "L'Electricien," an alloy of seventy parts of aluminum with twenty of tin and ten copper, makes a good solder for aluminum and will give perfect joints without galvanic action. The best flux to be used is potassium fluoride.

**High Resistance Materials for Heaters.**—A number of valuable advantages are gained in the construction of electric heaters, if the resisting material to be heated has a very high specific resistance and can be heated to a high temperature; that is, if the material can generate a relatively large amount of heat with a very small mass of the material. Less heat is then obtained in the apparatus itself and heating is accomplished more quickly, which reduces the stray cooling losses, as these continue for the whole time during which the apparatus is in use; with a small mass the heat losses after the apparatus has been cut off are also less; the use of higher temperatures also enables such operations as broiling or roasting to be accomplished.

Several devices have recently been introduced abroad with these ends in view, and from all accounts they seem to be quite successful. One of these is known as Parvillee heating material, which was recently described in most of the French electrical journals. He used a mixture of pulverized nickel with quartz, kaolin and some binding material, compressing it to 2000 kg. per sq. cm., and afterward baking it at a temperature of 1350 deg. C. Other metals will do, but nickel has been found to be the best. A resistance of 100 ohms is obtained in rods about 2 in. long, ⅜ in. wide and about ⅛ in. thick, which is claimed to be about a million times the specific resistance of the metal in it. Such a material can absorb 16,500 watts per kg. and will develop about fourteen times as much heat per square inch of surface as the usual materials, such as high resisting wires; the temperature is so high that a rod of copper touched to it will melt. Such a rod is said to cost only about 60 cents and will absorb 5 amperes at 110 volts. It seems that it does not deteriorate in course of time, at least not during 1400 hours, for which it is tested. Another advantage is that by having more of the metallic powder near the ends of the rods they can be made better conductors there, thus overcoming the difficulties in the conducting clamps. The heating apparatus is so arranged that the rods can be readily replaced, as they are inserted in clamps.

Somewhat similar advantages are also gained by what is known as the Le Roy heating device, which appears to be used in France, a brief illustration of which is given in "L'Electricien." It consists of a rod of silicon which, as it deteriorates in air, is inclosed in a vacuum tube provided with suitable terminals to enable the rods to be easily inserted between clamps or taken out, and as a number of them are usually used in parallel the amount of heat generated is easily regulated without external resistances. Some idea of the amount of heat generated by these is obtained from the following data: The little rods are about 4 ins. long, ⅜ in. broad and about ⅛ in.

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thick, and will dissipate about 150 watts, or about 1½ amperes at 100 volts. This corresponds to a dissipation of heat at the rate of 5 kg. calories per square centimeter of surface, or a consumption of about six watts per square centimeter. The ratio of the radiating surface as compared with wires is about one to four or six, which means that a very much smaller amount of resistance material is required to produce the same effect.

## NOTES.

**Increasing the Range of Wireless Telegraphy.**—Signor Marconi announces that he has successfully transmitted messages across the English Channel between the South Foreland and Boulogne.

**The Increased Capitalization of the Long Distance Telephone Company.** — The American Telephone & Telegraph Company has increased its authorized capital stock from $25,000,000 to $75,000,000. It is unofficially announced that the money raised by the issuance of this stock will be used in the building of extensions, but it is probable that this is a step in the consolidation of the various American Bell interests in one corporation.

**Another Universal Exposition** — The city of St. Louis wishes to take its turn in the holding of a World's Fair and proposes to commemorate in 1903 the centennial anniversary of the Louisiana purchase, by holding an exposition which it ambitiously hopes to make second to none in history. Plans have been laid to raise $17,500,000, which it is hoped can be made to go much further than the $18,600,000 spent in preparation for the Chicago fair, owing to the longer time which the proposed exhibition will have for building.

**The Promoting of Electric Vehicle Interests.** — The Electric Vehicle Co., of New York, whose work has been previously described in these columns, will in future give up the immediate control of local installations to licensed companies, of which it will become the parent organization. The New York plant has been sold to the New York Electric Cab & Transportation Co. The sub-companies will pay a license tax of one cent per capita of the population of the territory in which they operate, in addition to a small percentage of their gross receipts. The Electric Vehicle Co. was fostered by and is closely associated with the Electric Storage Battery Co., of Philadelphia.

**Trunk Lines Between Independent Telephone Exchanges in Michigan.**—Detroit, Mich., is well known as a stronghold of the independent telephone interests, the Detroit Telephone Company having over 5000 subscribers to its system. Few realize, however, that this city is the center of a radiating system of trunks owned by the New State Telephone Company, with over 2500 miles of pole lines reaching about 4500 telephones and extending as far as Grand Rapids, that is, completely across the lower peninsula of the State of Michigan. The New State Company has also established exchanges in almost all of the cities within a radius of 150 miles of Detroit.

**Infringement Suit on the Magnetic Blow-Out.**—In the suit brought by the General Electric Company against the Bullock Electric Company alleging infringement of patents on the magnetic blow-out, an application for a preliminary injunction was denied on March 6. The complainant contended that controllers put in by the Bullock Company in connection with the motor-driven presses of the Textile Publishing Company, of New York City, infringed the fundamental patents granted to Elihu Thomson. Evidence showed that these controllers were fitted with powerful electromagnets with extension plates to carry the lines of force to the fingers which made contact with buttons on the rotating cylinders of the controllers. The defense was based on lack of invention and non-patentability, so that if the case is carried through to a successful issue by the defendants the use of magnetic blow-outs will be open to the public.

**An Instructive Accident.**—A peculiar accident, illustrating how dependent upon power all modern industry—even in office buildings—has become, occurred during the first week in March in Manhattan Borough, New York City. The fundamental cause of the accident was the damage of a hydrant near the steam generating station of the New York Steam Company. Water was turned off, it is alleged, without notice and the steam plant had to shut down for lack of water, so that many buildings in the neighboring business district suddenly found their power plants without steam. The elevator service in these buildings was, of course, suspended, and for two hours or more the occupants were compelled to climb from ten to twenty flights of stairs on foot; electric lighting isolated plants were shut down, and even the Western Union Telegraph Company was affected, as its generators are run by steam taken from the street supply.

**The Emissivity of Incandescent Bodies.** —Some views of interest in connection with the development now going on of new electric lamps have been given by Prof. Elihu Thomson, in a letter to the "Electrical Review." There is a great difference of opinion as to the value of different substances in emitting light. By Kirchhoff's law, a body raised to incandescence emits all the rays it otherwise would absorb. If carbon is used as the incandescent body, it gives out besides visible light rays the invisible heat rays with a longer wave length and the ultra-violet or the so-called chemical rays with a shorter wave length. On this account the efficiency of the carbon filament as a producer of visible rays is certain to be small. German scientists, notably those who have developed the Welsbach and similar systems of incandescent gas lighting, claim that certain materials, such as magnesia and the rare earths, have a peculiar selective emission, a remarkably large proportion of the rays they emit being visible and hence useful in illumination. Others dispute this idea, contending that the intrinsic brilliancy of all substances is practically the same at a given temperature. Prof. Thomson believes that such materials only possess this peculiar property under specific conditions of use in a reducing flame. He states that his experiments indicate that the light given out by the Welsbach mantle is largely due to the union of the gases taking place within the pores. It is well known that the calcium or lime light is far more intense when the lime is in the body of the flame than when it is in the tip where combustion is practically completed, although the temperature at the latter is probably as high as at the former point.

**New Telephone Rates in Germany.**—The telegraph administration of the German government has established a new tariff for telephone subscribers. It is based on the principle that the larger the number of subscribers to an exchange the higher is the cost per subscriber. The tariff is worked out on the message rate basis, the fixed charge increasing with the number of subscribers in the district reached. The lowest rate is the equivalent of $14.50 per year and applies to instruments connected with exchanges reaching less than 1000 subscribers, the sliding scale running up from this to $24 per year for instruments in districts having over 20,000 subscribers. In addition, service is paid for at the rate of $5 for the first 500 conversations per annum with a sliding scale running up to $13 for any number of conversations. Thus, the minimum cost of the telephone is about $19.50 per year, this rate applying to a telephone with less than 500 conversations per annum and in a city with less than 1000 subscribers. The maximum cost in cities of 20,000 subscribers or over, and with 3000 conversations per annum or over, is about $50 per annum. Long distance toll rates are also low compared with those in this country.

**Instructions to Exhibitors at the Street Railway Convention.**—The executive committee of the American Street Railway Association has made some unusually complete arrangements for the exhibitors at the coming convention, to be held in Chicago, Oct. 17 to 20, 1899. The exhibition and convention will be held at Tattersalls, the largest exhibition hall in the city. All stairways to the convention hall lead from the inside, insuring the attention of visitors to the exhibits. Friday, the 20th, has been set apart for the examination of exhibits. No session of the association will be held on that day and no entertainments whatever will be given by the local committee. Space will be sold at the rate of 10 cts. per square ft. No space of less than 100 square ft. will be assigned, but applicants may have as many multiples of this quantity as they wish, all in one body. Cars, switches and ploughs will be placed outside of the building on the street. The building has been rented from Oct. 10th to 24th, to give exhibitors an

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opportunity to ship their goods early as well as ample time to remove them. Space must be applied for by Sept. 1. The committee on exhibits will make contracts with carpenters, electrical workers and so forth, so that the exhibitors will not be over-charged. The announcement also suggests that arrangements be made to have the building open in the evening on account of the interest which it is anticipated the display will occasion.

**Nikola Tesla on Liquid Interrupters.**—In an interesting letter to the "Electrical Review" Mr. Tesla tells some of his experiences with liquid interrupters of the type which has become connected with the name of Wehnelt. As is well known, Mr. Tesla has done some very elaborate work with circuit interrupters, chiefly of the type in which a stream of mercury is projected against metallic contacts or is itself broken by insulating teeth. With these he has attained a remarkably high efficiency of transformation, an essential consideration in his work of vacuum-tube lighting, so that the heavy losses in the Wehnelt interrupter appear to him to be a serious objection; but it should be noted that for an ordinary experimenter who wishes to obtain results by simple means regardless of the power used within certain limits, the Wehnelt interrupter is a highly effective device. Mr. Tesla states that, of the total energy supplied from the mains, there is obtainable from the secondary scarcely one-fourth of that which a well constructed mechanical break will give. He points out further that the small terminal is surrounded by gaseous bubbles across which the contact is made when the liquid is driven inward by the hydrostatic pressure of the fluid column. By increasing the height of the latter the frequency can be increased. He suggests the use of a vertical glass tube, six or eight feet long with the interrupting device close to the bottom. The electrode should be very small to insure regularity of operation and it is not necessary to use platinum.

**The Largest Transformers in the World.**—For the transmission of power from the Niagara Falls Power Company's hydraulic plant to the mammoth carbide plant to be erected by the Union Carbide Company, at Niagara Falls there have been ordered seven transformers rated at 2500 h.p. each. These will be used for stepping up the voltage from the generator pressure of 2200 volts two-phase to 4400 volts three-phase. They may also be used in stepping up to the 11,000 or 22,000 volts three-phase of the long distance lines to Buffalo and other places or as reducing transformers with the same ratios. At present the largest size of transformers in service the world over is rated at just one-half this output, 935 k.w. or 1250 h.p. Ten such transformers are in use in the Niagara Falls Power Company's plant. Others rated at 2000 h.p. have been ordered by the Union Carbide Company, but not as yet built. The new 2500-h.p. transformers will be built by the Westinghouse Electric & Manufacturing Company of its standard oil insulated and water cooled type, similar to three of 850 k.w. each, now in use in the Ohio street sub-station of the Cataract Power & Conduit Company in Buffalo. The estimated efficiency of the new transformers is remarkably high. At full load it will be considerably over 98 per cent, at half load, 98 per cent, and at one-quarter load over 97 per cent.

**The Propagation of Long Electrical Waves.**—At a meeting of the American Institute of Electrical Engineers held in New York March 22d, Prof. M. I. Pupin presented a paper describing some new experimental apparatus for studying the phenomena of the electrical waves which occur on long-distance telephone and power transmission lines. As is well known, when waves of current are sent into submarine cables possessing resistance and capacity, they become more and more attenuated with each mile of cable traversed, but in the case of overhead lines of comparatively low capacity and high self-induction the action is entirely different. The waves sent out from the transmitting end are reflected from the receiving apparatus, giving in the line a phenomenon corresponding to the interference of light and causing fixed nodes and loops; that is to say, the reflected waves at some portions of the line reinforce or add themselves to the outgoing waves and at other portions partly neutralize them, so that an ammeter inserted in a line would show permanently a greater current at some points than at others. The distribution of the voltage is similarly humped. Professor Pupin's theoretical discussion proves that this wavy distribution of the current along the line can be mathematically determined and a very simple analogue obtained in the vibrations of a cord or rope suspended at its two ends and loaded at its center. Professor Pupin has built artificial land lines corresponding to the Muirhead artificial cables, but possessing distributed capacity, self-induction and resistance. One form of these consists of coils wound with an intermediate sheet of tinfoil to give the distributed capacity, each coil having the properties of 10 miles of the telephone line now in service between New York and Chicago. It is hoped that with apparatus of this kind many of the phenomena of long distance transmission may be studied more scientifically than they have been in the past. But little is known about these waves, as the oscillations are forced and differ, therefore, from the free oscillations which, in the higher frequencies known as Hertz waves, have been very carefully studied. The general outcome of the study so far given seems to show that more distributed self-induction would improve the transmission of speech.

**Discovery of the Non-Arcing Metals.**—At a meeting of the New York Electrical Society, on March 9th, Mr. A. J. Wurts concluded his address on the subject of lightning arresters with an interesting account of his accidental discovery of the now well-known non-arcing metals in the shops of the Westinghouse Electric and Manufacturing Co.

He was experimenting with a system of lightning arresters, which consisted of a distribution of spark gaps over the line wires as line arresters and a common circuit-interrupting device in the station. In other words, he was trying to avoid the costly and unsatisfactory automatic lightning arresters used at that time. The arrangement consisted of spark gaps on the line between two carbon cylinders, and a circuit breaker in the station, which, upon a short circuit through any one of the lightning arresters on the line, would open and immediately close again. Upon experimenting with this system it was found that when a short circuit was established across any one of the spark gaps between carbon cylinders, the latter would become white hot, and although the circuit breaker operated promptly in opening the circuit, it also closed so quickly that the short circuit was re-established across the white-hot carbon cylinders.

To avoid this difficulty he immediately had cylinders made of brass, cut from brass rod. These were placed close together and connected across the terminals of a large 1000-volt generator, with the result that an arc started by a piece of tinfoil did not persist as one did started between the carbon cylinders. Thinking that the extinguishment of the arc was due to the cooling action of the metallic bodies, he had some large cylinders cast (dimensions, 3x3 inches. These were connected up with a source of powerful currents, and a discharge started, the result being utter disappointment as the cylinders were completely welded together by the violent arc that struck between them. On inquiry he found that these cylinders were made of copper alloyed with tin, while the rolled ones were made of copper alloyed with zinc. This gave a clue, which was followed by ordering cylinders of both tin and zinc. The former arced as badly as those of tin-brass, while the latter showed the remarkable suppresion of the arc which has since been ascribed to the formation of insulating metallic vapors.

Further investigation proved that of the base metals zinc, bismuth, antimony, cadmium and mercury exhibited this same peculiar property, the latter perhaps to a greater extent than any of the others. Mercury, of course, must be used as an amalgam on the surface of another metal. The useful life, therefore, of an arrester made with it is limited by the eating away of the amalgam. Zinc was found to give the best results at minimum cost. Pure zinc was found to pit badly, while copper, so used, forms beads. By the combination of the two metals the one effect neutralizes the other, giving a surface which is very little disturbed by repeated discharges.

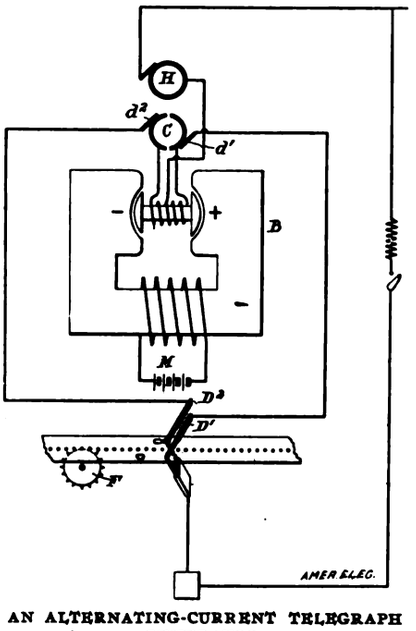
**The New York Edison Company.**—The Edison Electric Illuminating Company of New York has issued its last annual report previous to its incorporation with the New York Gas, Electric Light, Heat & Power Company. The report, as usual, shows a gratifying increase in this very prosperous enterprise. The gross station earnings

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were for the year 1898 approximately $2,900,000, against $2,460,000 of the year before. The total load connected, exclusive of emergency or break-down service, has grown to 890,000—16-c.p. equivalent. The most interesting part of the report is the description of the water-side station proposed for supplying the Edison system in general with high tension 3-phase current, which would be transformed into low tension direct current by rotary converters in sub-stations to which the present generating stations would be altered. With this general idea in view a high tension transmission line has already been established between the Duane Street and the Thirty-ninth Street stations. The transmitting system consists of rotary converters and transformers with a capacity of about 1000 k.w. at each end. This is used to transmit in either direction, one station helping out the other at any time. In connection with it a storage battery with a capacity of 4000 ampere hours at 250 volts has been installed at the Thirty-ninth Street end of the line. The water-side station was planned by an engineering commission consisting of Messrs. John W. Lieb, Jr., General Manager; John Van Vleck, Constructing Engineer, and Arthur Williams, General Inspector, who spent two months in Europe studying the problems of electrical and steam plants. The plans provided for a station approximately 200 ft. x 400 ft. in size which should have an economical rating of 90,000 h.p. and an overload capacity of 135,000 h.p., with the possibility of extending this to 150,000 rated or 225,000 overload horse power. The plan comprehended a central main operating room approximately 100 ft. wide, giving space for fourteen 6000 rated h.p. units in two rows, one on each side of a central aisle. Each of these units would consist of a triple expansion 3-crank vertical engine, built for superheated steam at 500 deg. F. and 200 lbs. pressure, coupled to a 3-phase 6600-volt generator. Two half size or 3000 h.p. units would also be included, these being of the double-current type, capable of giving either direct or 3-phase current. This main operating room would be covered by a steel truss roof and spanned by the usual crane, and flanking it on each side would be a long boiler-house with two tiers of boilers, one over the other, surmounted by coal bunkers and above them storage battery rooms and repair shops. All steam piping, auxiliary apparatus and smoke flues would be placed in a 10-ft. space, separating the boiler rooms from the main engine or operating room. The stacks, one for each group of four boilers, would surmount this intermediate 10-ft. space. It was hoped that on this plan the advantages of wholesale generation and high-tension transmission would be combined with the Edison system of supply from district centers at maximum demand and the general advantages of the Edison distributing system, with a relative economy that would prove exceptional, permitting reductions in price which would make electric lighting at last "the light of the people."

## SOME ELECTRICAL PATENTS OF THE MONTH.

**An Alternating-Current Telegraph Generator.**—Some one has well said that telegraphy is simply long-distance transmission of power on a small scale. The development of power transmission has tended steadily from direct to alternating currents, and telegraphy seems to be following its example. The smooth, sinusoidal




AN ALTERNATING-CURRENT TELEGRAPH GENERATOR.

curves of current generated by an alternating dynamo seem to go through a highly inductive line or one like a submarine cable containing large capacity, more easily than do currents from a battery or a direct-current dynamo. The waves also reach the receiving end less distorted and less run together than do direct-current impulses.

A generator specially designed for this purpose has been patented by Messrs. A. C. Crehore and G. O. Squier, the well-known inventors of the synchronograph and other apparatus for high-speed land and submarine telegraphy.

For the production of signals it is necessary in such systems to omit various combinations of the alternating current waves, the half period of positive current or the half period of negative current being cut out by the operation of the transmitter. The general scheme of such a generator and transmitter is shown in the accompanying figure, in which B represents a bipolar generator with a shuttle-wound armature and a field excited by the storage battery M. The winding on the armature shuttle is tapped at its middle point to the collector ring H, and the two ends are brought out to the half rings of the rectifier C. On these bear the brushes $d^1$ and $d^2$ respectively connected with the contacts of the make and break device, $D^1$ and $D^2$. These bear on a perforated strip of paper, similar to that of the ordinary Wheatstone automatic transmitter. This is driven by means of the central row of perforations which engage with the teeth of wheel F, and this wheel is geared to the shaft of the generator so that it revolves at a speed exactly proportional with the frequency of the currents from the latter.

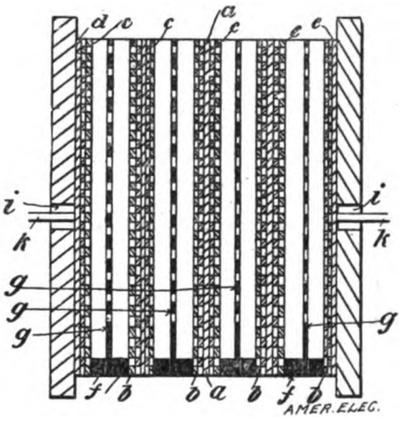
Holes may be punched in the tape such that they will allow contact of either one brush or the other for a time exactly equal to the time of a wave of the current. Obviously the rectifier C supplies waves of one polarity only to the brush $D^1$, and of the other polarity only to the brush $D^2$ so that holes punched in one side of the paper will allow only positive currents to go to line and on the other side of the paper only negative currents.

The patent further describes in detail bipolar machines of this type for the low frequency used in submarine work, and multipolar machines for the comparatively high frequency of land line transmission, with the necessary attachments for driving the paper tape, these driving attachments being operated through a clutch by which they may be thrown into or out of engagement.

Patent No. 620,746, issued March 7.

**A New Storage Battery Plate.**—There are now on the market electric storage batteries in which the positive plate of one cell becomes the negative plate of the next, and so on through the accumulator, thus giving a complete battery yielding 100 volts or more inside of one tank or receptacle. Such batteries are particularly convenient for electric vehicle use. Some new features in this line are described in the recent patent issued to Rankin Kennedy, the well-known English electrical engineer.

The accompanying figure shows a battery made up in this way containing three




A NEW STORAGE BATTERY PLATE.

such double plates and two end plates, the whole constituting four cells, giving between 8 and 9 volts. The double plates consist of solid central sheets of lead a coated and prepared on one side with perforated sheets b and on the other side with perforated sheets c, treated as described below. Between the bottoms of these plates and up each side are run soft rubber gaskets f holding them a proper distance apart and between the gaskets are hard rubber

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diaphragms g which prevent the plates from touching and short circuiting in case of extreme buckling. The whole structure is tightly bolted together between walls of an insulating and acid-retaining tank, preferably of wood. The terminals k and k are brought out through the holes i and i in these walls.

The plates are prepared as follows: After being cut to a uniform size the lead sheets are flattened and soaked in a hot solution of nitric acid and water of 5 per cent. strength, then washed in clean water, and the solid central sheet painted (while still wet) on one side with a paint composed of red lead and dilute sulphuric acid of a strength equal to 13° Baumé. The other side of the sheet is covered with a paint composed of litharge and dilute sulphuric acid of strength equal to 24° Baumé. The sheet is then allowed to dry slowly. The perforated sheets are, while still wet, coated with the red lead and litharge paints on both sides, care being taken not to fill up the perforations. Half of the perforated sheets are painted with litharge and the remainder with red lead. The sheets are allowed to dry slowly. By coating the sheets by painting litharge and red lead onto chemically clean surfaces the coating combines with the lead sheets and remains firmly attached thereto.

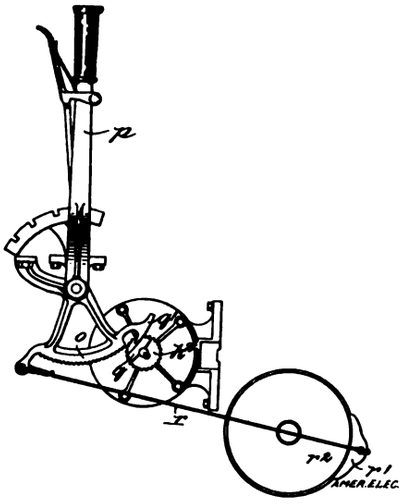
To form a complete plate, a central lead sheet is placed between one, two, three or more (according to the required capacity of the plate) of the coated perforated sheets, all the red lead-coated sheets being placed on the red lead-coated side of the central sheet, and all the litharge-covered sheets on the other side thereof. The whole is then riveted, fused, or soldered together to insure electrical contact. The complete plate is then made solid all around the edges by fusing or soldering, so that no liquid can escape from the plate. The lead sheets used to form the plates are about No. 24 B. W. G., and the completed plate is made up of a sufficient number of perforated sheets to bring the thickness to about ½ in. The perforations are from 1-16 to ⅛ of an inch in diameter.

Patent No. 620,593, issued March 7.

**The Controlling Apparatus of Electric Automobiles.**—Barring the uncertain elements due to the independent will power of the animal, the control of horse-drawn vehicles is accomplished by very simple means. With the automobile vehicle it is different. In place of the one pair of reins for controlling the speed and direction of motion, there is necessary, as a rule, a steering lever, a controlling lever and a brake. The simultaneous use of these three different pieces of controlling mechanism calls for a certain amount of training, which requirement makes the automobile unsafe in amateur hands.

Two of these controlling mechanisms, namely the brake and the speed controlling lever, are often interlocked, so that when the brake is on, the motors cannot be started, or the brake put on while the current is flowing through the motors. A new device, patented by C. E. Woods of the Fischer Equipment Company, of Chicago, goes further and makes the brake and the speed controller operative from the same handle, motion of which in one direction turns current into the motors, and in the other direction applies the brake.

The general scheme of the apparatus is




THE CONTROLLING APPARATUS OF ELECTRIC AUTOMOBILES.

shown diagramatically in the accompanying figure, where p is the handle provided with the usual latch and connected to the segmental gear, o. Attached also to the main lever is the rod, r, which manipulates the brake shoe, $r^1$, on the brake pulley, $r^2$. The arrangement is such that this brake shoe is not drawn into contact with the wheel until the controlling cylinder is turned to the "off" position, where all current is turned off from the motors. Further the controlling cylinder is locked in this position by means of a cam or lug, q, on the controller shaft, engaging with the shoe, $q^1$, on the lever and gear shaft. These parts hold the controlling cylinder firmly in the "off" position and at a point suitable for the proper engagement of the segmental gear and pinion when the lever is again moved to a running notch.

Patent No. 620,628, issued March 7.

**A Paste for Accumulator Plates.**—A new method of making the paste which is applied to the plates of storage battery cells constructed on the Faure or pasted method, has been patented by A. Schanschiff. The specifications point out that the composition made in the usual way is not entirely penetrated by the sulphuric acid, so that the electric current has to pass through a dry resisting material on its way to the conducting grid, giving a high ohmic drop, and, in case of excessive overload, a heating which expands and disintegrates the plates. The new method consists in mixing finely powdered charcoal with formic acid and tartaric acid, adding sulphuric acid and afterwards adding the oxide of lead, minium for the positive and litharge for the negative plate. When cold this forms a dough-like paste, which is heated, compressed and applied to the plate. During the process of formation the organic acids are destroyed and the paste left porous, absorbent and highly conductive, owing to the presence of the carbon.

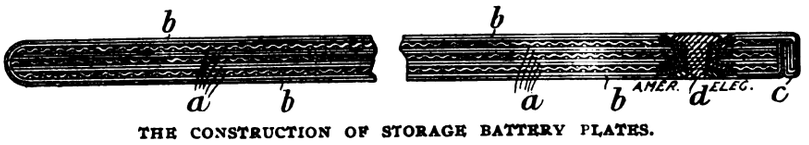
Patent No. 621,150. Issued March 14th.

**The Construction of Storage Battery Plates.**—A new method of constructing the plates for storage batteries of the Plante type has been patented by C. P. Elieson, of London, Eng., an engineer who has done considerable work in the development of automobiles. The improved construction of the plate is shown in the accompanying figure, which is a horizontal section. The plate is built up of several layers a of perforated and corrugated sheet lead, the corrugations of alternate layers running at right angles to each other so as to leave spaces between the plates for the materials developed during the process of formation.

As the figure shows, the outer lead sheet is wrapped around the others and folded or rolled in at one end as appears at c, the joint being afterwards lead burned. The assembled sheets are further fastened together by lead rivets d, also burned in, and the tops and bottoms of the plates are burned into lead channels which complete the enclosure and give good electrical connection between the various sheets. The assembled plate is then rolled or compressed to give a general flatness and is afterwards well coated over with a bituminous or resinous varnish to preserve the outer sheet while those within it are subjected to the electro-chemical formation.

Patent No. 621,048. Issued March 14th.

**A Frequency Changer.**—It is often desirable to transform alternating currents of one frequency to those of another. For example, on the Niagara-Buffalo transmission line, the frequency of the alternating currents is 25 cycles per second, while the currents delivered to the lighting mains in Buffalo must have a higher frequency for the satisfactory operation of incandescent and arc lights. In this case 62½ cycles is obtained by means of 25 cycle motors, coupled to 62½ cycle generators. All the power passing through the combination undergoes a double transformation from electrical to mechanical and mechanical to electrical power.



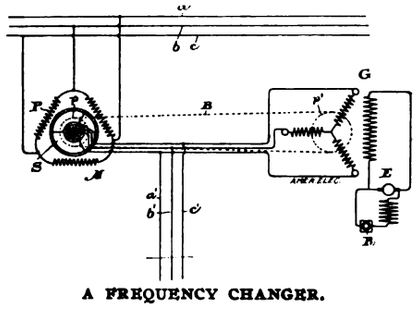

THE CONSTRUCTION OF STORAGE BATTERY PLATES.

Another type of machine is used somewhat in which only a part of the power is transformed mechanically, the machine resembling structurally an induction motor, the armature of which is wound with coils connected to collector rings. The primary of this induction machine is supplied with multiphase currents at a low frequency, giving a rotating field, and the secondary is mechanically revolved by a motor in a direction opposite to that of the rotating field. There is thus impressed upon the

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secondary a frequency higher than that of the currents delivered to the primary. Such a machine is used by the Kings County Electric Light & Power Co., in Brooklyn, to change the 25-cycle power generated at its union power station to 60-cycle power for its alternating current lighting circuits.

A very similar combination for changing from a high to a low frequency has been patented by Mr. C. P. Steinmetz, the general plan of which is shown in the accompanying figure, where a, b and c are the mains of a three-phase system supplying



A FREQUENCY CHANGER.

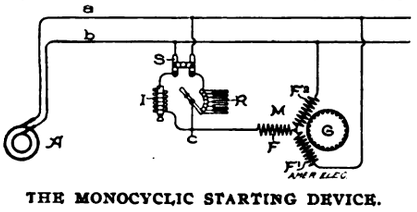
power to the primary coils, P, of an induction or rotary field machine, M. The rotating secondary or armature, S, of this machine is fitted with a winding connected through collector rings and brushes to the three leads a', b' and c', which are also connected with the three-phase winding of a synchronous machine shown at G. The induction machine and the synchronous machine are mechanically connected, preferably coupled together, but shown in the figure as joined by the belt B.

The rotary field induced by the primary P will drag the secondary S, which will in turn drive the generator G; but S and G must, on account of their electrical connection, run in synchronism with each other. The frequency generated in S will be proportional to the speed of the rotating field, minus the speed of rotation of the armature, while the frequency in G will be proportionate to the latter quantity. Thus, if G has the same number of poles as S and they are coupled together, S will run at one-half the speed of the rotating field induced by the coils P and the frequency on the mains a', b' and c' will be one-half that on the mains a, b and c. In this case one-half the power will be transformed magnetically from one circuit to the other through the transformer action of the induction motor and the other half will be transformed mechanically, being first turned over to the generator G and then changed back to electrical power. In case G has more poles than S, the mechanical rotation will be slower, the frequency reduction will be greater and the proportion of the power which undergoes the double transformation will also be greater. If the power is supplied at low frequency to the mains a', b' and c', and drawn off at a higher frequency from the mains a, b and c, the arrangement becomes exactly that referred to as used by the Kings County Electric Light & Power Co.

Patent No. 620,990. Issued March 14th.

**The Monocyclic Starting Device.**—Alternating current motors of the pure induction type—that is, those having an armature winding simply closed upon itself and not connected with the source of current—when supplied with single-phase currents, run satisfactorily but have absolutely no turning moment when standing still. The single-phase current gives a purely alternating field across the air gap instead of the rotary field which can be obtained from multiphase currents. When the motor is running, the lagging currents in the secondary or armature winding develop a rotary field which will keep the motor in rotation practically as well as though it were run on multiphase circuits, but at standstill there is as great a tendency to run in one direction as the other, and unless some auxiliary device is employed to start the motor mechanically or to develop a rotary field, the motor is stalled.

One of the most satisfactory devices for temporarily giving the needed phase displacement to start the motor is the monocyclic starting device, patented by C. P. Steinmetz and E. J. Berg. The general plan of connections is shown in the accompanying figure, where A represents a single-phase alternator supplying current to the mains a and b. M is a motor shown with a short-circuited or squirrel-cage armature G and three primary windings, F, $F^1$ and $F^2$, Y-connected. $F^1$ and $F^2$ are in series



THE MONOCYCLIC STARTING DEVICE.

with each other across the mains and from their point of connection the third winding F is tapped off to the auxiliary starting device. This consists of a non-inductive resistance R connected in series with a highly inductive coil I straight across the two mains through the double pole switch S. The middle point C, between the inductive and non-inductive resistance, is connected to the motor winding F. The two resistances are shown with adjusting devices, the resistance R having a handle by means of which more or less of it can be cut out, and the inductive coil I an iron core which can be slipped into or out from the coil. The combination of the self-induction of I and the resistance of R gives to the coil F a current decidedly out of phase with those in $F^1$ and $F^2$, giving a rotary field.

Patent No. 620,988. Issued March 14th.

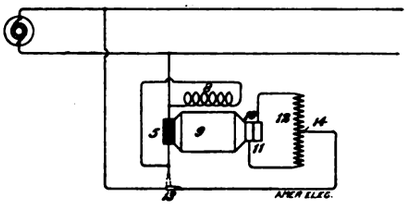
**Vacuum as a Dielectric for Cables.**—It is well known that dry air is one of the most satisfactory insulating mediums for telephone cables, owing to its low specific inductive capacity and high dielectric strength. For this reason untreated paper cables have come into considerable use. It has been proposed to maintain a pressure within such cables in order to prevent moisture from entering through any pinholes or other leaks through the lead sheath. A patent taken out by N. G. Warth makes the antagonistic proposition of maintaining a vacuum within the cable. The purpose of this vacuum is to further diminish the specific inductive capacity and increase the resistance and dielectric strength of the paper as well as to reduce the combustion in case of sparking across from conductor to conductor.

Patent No. 621,001. Issued March 14th.

**Method of Motor Speed Control.**—In general the control of the speed of direct-current motors on constant-potential circuits is accomplished either by inserting a resistance in series with an armature or by varying the strength of the field. The first method is wasteful of power and the second wasteful of motor output; that is to say, it involves an increase of the size, weight and first cost of the motor for a given load.

A novel solution of this problem has been patented by Mr. B. G. Lamme, of the Westinghouse Electric & Manufacturing Company. Referring to the accompanying figure, 1 represents a direct-current generator supplying power to the direct-current motor, the armature of which is indicated at 9. This, as shown, has its field winding, 8, connected in shunt across the brushes bearing on its commutator, 5. It is also connected with a pair of collector rings, 10 and 11, tapped into the same armature winding. The brushes bearing upon these collecting rings are connected to the opposite terminals of the inductive winding, 12, which is preferably a transformer core wound with a single coil tapped out at its middle point, 14.

When the motor is in motion there will obviously be generated between the two collector rings an alternating current which will be impressed upon the winding, 12, and choked back by the self-induction thereof. As the armature rotates, the commutator segment connected to the collector ring 10 travels alternately from one commutator brush to the other, and the connection of the collector ring 11 also travels from brush to brush, but always exactly opposite to that of collector ring 10. Thus as one terminal of the coil becomes posi-



METHOD OF MOTOR SPEED CONTROL.

tive the other becomes negative, and vice versa, the middle point of coil 12 remaining always neutral or with a potential midway between that of the line terminals. The motor is started in the ordinary way with the switch in the dotted position, but to increase its speed without weakening its field the switch 13 is thrown into the full line position connecting the full voltage between one brush on the commutator and the middle of the armature through the coil 12. This practically doubles the speed as the back e.m.f. of the motor is cut in two. The voltage across the commutator of the motor of course increases, and this increases the current in the shunt field 8, reducing somewhat the rise in speed.

Patent No. 620,333, issued Feb. 28, 1899.

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**Removal Notice.**

On April 10th the offices of publication of the American Electrician will be moved to the Beard Building, New York City. Subscribers, contributors and other correspondents are requested to note the new address, which is 120 Liberty Street, New York.

**Publishers' Announcement.**

Owing to circumstances beyond our control, the preparation of the premium to subscribers who promptly renew their subscriptions direct to the publishers, has been greatly delayed. We are glad to say that the pamphlet "Diagrams of Electrical Connections," is now in press and will be delivered in the course of the month to those entitled to it.

**A New Department.**

Beginning with this issue of the American Electrician there will be published notices of those of the patents issued during the previous month which appear to the editor to be of particular interest. In many lines of electrical work, men with the real inventive instinct foresee the tendency of future development and improve the opportunity the government gives them to benefit by their foresight. Others disclose in their applications the results of much original and valuable research. A study of their opinions as disclosed by patent specifications gives much information that can be obtained in no other way. The descriptions in these columns are necessarily limited, both in number and in length, owing to lack of space, but the attempt will be made to make this department valuable to the reader by a few words showing the problem the inventor strives to solve and his method of solution. The criticism of the reader is invited in this department as well as in the balance of the paper.

**The Wehnelt Interrupter.**

During the past month the additions to the knowledge about this recent invention have been many and valuable. The advantages and disadvantages of the new instrument have been pretty well determined and the various explanations of its action are well on the road to unity in a fixed theory. While the instrument is by no means an efficient one, wasting most of the energy it receives, it is simple, cheap, not easily deranged and highly effective where induction coil discharges are wanted and the cost of a k.w. is of small consideration.

In general the value of an interrupting device depends upon the abruptness or suddenness of the break. The more nearly instantaneously its resistance runs from zero to infinity, the greater is the discharge given by the coil to which it is connected. When the circuit is opened in a mechanical break, the current tends to persist, volatilizes the metal terminals, and forms a small arc which gradually dies away. In the electrolytic interrupter considerable current is concentrated through a small area of contact between platinum and water. Electrolysis of the water evolves oxygen which forms an insulating sheath. The current apparently arcs across this for a very brief interval of time, but is quickly drowned out by the water or blown out by the expansion of the sheath when heated by the arc. The presence of water prevents the melting of the metal and gives the arc nothing to feed upon. The break thus effected is immediately followed by a make, caused perhaps by the inward pressure of the fluid column on the gaseous sheath.

In a contribution on other pages of this issue, by Messrs. Charles T. Child and George T. Hanchett, it is pointed out that a coil in multiple with the interrupter is affected very much as is one in series with it. In the latter case the break of the circuit in the interrupter suddenly stops the current flowing through the coil. In the former case the break suddenly removes a short circuit about the coil and forces current through it. An interesting possibility is the combination of these two actions within one induction coil, which could be accomplished by winding two primaries in opposite directions upon the same core, one of them connected in series and the other in multiple with the interrupter. The effect then would be to reverse the magnetization instead of simply increasing and diminishing it, in which case the output might be expected to be greater, the efficiency higher and the use of an induction coil or transformer with a closed magnetic circuit possible. The rapidity of the breaks of the interrupter is so great that the iron core of the induction coil probably does not get time to more than partially demagnetize before the circuit is made again. Hence the use of a reverse winding, such as that proposed, might be expected to increase greatly the demagnetization and to improve the action.

**The Problems of Fan Motor Design.**

One of the most popular luxuries available from electric power and one coming to be considered a necessity, is the small electric fan. So extensive has its use become in many cities that it gives in hot weather a day load of no mean importance to the central station and goes a long way toward equalizing the summer and winter receipts. The growth of its use has been gradual and few probably realize how large a proportion of the total current on distributing mains finally finds its way through these small motors. One of the most forcible indications, although an unfortunate one, of its magnitude is the serious lagging current which it often throws upon alternating current systems.

The problems involved in the design of the fan motor are not as small as its size, when compared with comparatively enormous power motors, would tend to indicate. The conditions under which it operates are peculiarly trying. As a rule it receives no attention from the beginning to the end of the season, or worse, what

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attention it does receive is from unskilled or meddlesome hands. Its lubrication must, therefore, be provided automatically for a period as near perpetuity as possible. Its journals are never rebabbitted, its commutator is never turned, polished or even cleaned and its brushes are only renewed when it refuses to run longer.

Perhaps the most serious requirement that the designer must comply with is the question of cost; the number of parts in the motor must be worked down to the very minimum and each small casting, screw or nut made to fulfill as many functions as possible. The eager competition of many manufacturers and the unskilled criticism of most users occasions this limitation.

In the matter of efficiency the requirements are also much more severe than would appear from its small load. In most instances its use is a luxury and the power supplied to it is paid for at the rate of 15 or 20 cts. per k.w. hour. If the motor requires 100 watts and runs 10 hours per day, it costs for power $4 or $5 a month, making it to many a rather expensive luxury. The efficiency of the fan motor cannot, because of its size, compare with the 90 per cent. or more obtainable with large motors used on heavy loads, but ranges more near 50 per cent. If taken as the ratio between the power given to the air by setting it in motion, to the electrical input, the figure falls away below this, so there are opportunities to perhaps double or treble the efficiency by slight changes in design; whereas on large motors, the most carefully worked out improvements can only hope to gain 2 or 3 per cent. At least one fan motor is now made with a field commuting switch by which the speed can be adjusted without using wasteful dead resistance, but by varying the strength of the field.

The ideal simplicity so necessary in fan motors is most easily obtained with the alternating current machine, which requires no commutator nor even collector rings or brushes, but does require, as do large induction motors, a very narrow air gap and a low induction in the iron to keep down the lagging currents, which are at the best excessive in such small machines. The designer of the alternating current motor also encounters difficulties in obtaining low speeds at high frequencies. With a desk fan running at 1000 to 1500 r.p.m. the problem is not a difficult one, but with ceiling fans running at one-tenth this speeds it becomes serious. The reason for this is that to obtain anything like the efficiency desired the fan must run somewhere near synchronism with the current supplied to it. Assuming that the frequency is 16,000 alternations per minute and the fan runs at a speed of 150 r.p.m. and has a 25 per cent slip, it must have 80 poles, a number quite out of the question for motors of this small size, as they would become thin teeth with an absolutely prohibitory magnetic leakage. The production of a direct current motor to run satisfactorily at this slow speed without excessive weight and cost is a distinct achievement, although not as difficult as the problem of the alternating current type. The chief triumph of the direct current designer has been the construction of motors of this small size which can be run singly across circuits with as high a pressure as 500 volts.

The alternating current induction motor, pure and simple, when fed by single-phase currents is non-starting, that is, it has no tendency to turn until it gets in motion. This is overcome in fan motors as a rule by putting in what are known as shading coils, that is, short circuited copper strips around parts or corners of the poles. The currents induced in these give a magnetization out of phase with that of the main body of the poles, thus giving a rotating field which starts the motor in motion. Once up to speed the armature or secondary gives the necessary cross magnetization so that the starting coils are no longer necessary. As they cause a constant waste of energy they may be cut out, and in one motor at least they are connected with the switch in such a way that they are cut out in the running position and only closed while starting.

**Armature Reaction in Alternating Dynamos.**

Many engineers of alternating current plants, especially those transmitting power to distant motors, or feeding long-transmission lines with high-capacity or underground cables, have been puzzled by a rise of e.m.f. at the machine terminals with the throwing on of the load. It is well known that under certain conditions the voltage at the distant end of a transmission circuit or feeder may be higher than at the generating station supplying it, the current apparently rising in voltage along the line. The latter action is, of course, due to the effect of leading or condenser currents on the self-induction of the line and can often be made valuable for compounding or over-compounding systems without rectifiers or composite windings on the machines.

The rise of the machine voltage with the load is due to the same cause, namely, leading or condensing currents, which in this case affect the field strength of the machine. The action is best explained by reference to the familiar unitooth or pole wound dynamos, in which the armature coils are wound about large poles or teeth, equal in number to the poles of the field. In such a machine the e.m.f. is a maximum when the winding on the armature teeth is crossing from a position in front of one of the field poles to its next neighbor, and if the load is non-inductive the current in the armature will be in phase with this e.m.f., that is, will be at a maximum when the armature tooth is midway between the field poles. In this position the armature current will tend to weaken one pole as much as it tends to strengthen the other, the aggregate effect on the main field strength being nil.

If, however, there is a large capacity in the circuit or other synchronous machines giving a capacity effect, the current will rise in the armature windings before the tooth reaches mid-position between the poles and will tend to magnetize the fields more strongly. On the other hand, if there is considerable self-induction in the circuit making the current lag behind the impressed e.m.f. the current will not rise in the windings until the tooth has passed beyond the mid-position, and will tend to oppose the field by setting up lines of force against it. This is the reason that induction motors, arc lamps, reactive coils and other devices which take lagging current interfere so badly with the regulation of alternating current dynamos. The action is the same in multi-tooth machines, with distributed windings, and differs in polyphase machinery only by being more continuous and less pulsatory in character.

The same reasoning explains why two alternators may be safely connected in parallel with each other when giving quite different voltages. The one with the higher voltage immediately gives out a lagging current which pulls down its field strength. This current enters the machine with the weaker fields and is there a leading current which builds up the field strength, the effect on the two machines adjusting their voltages to the same value. So great is this effect in some dynamos that one generator may be run without any current in its field coils whatever, giving full voltage by a field excitation entirely set up by the armature reaction. Machines with a large ratio of armature to field ampere turns naturally exhibit this effect more strongly than do those with powerful fields and weak armatures or, as they are called, machines of close regulation.

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## THE NERNST LAMP.

This lamp, recently invented by the physicist, Nernst, of Göttingen, consists of a rod of dense magnesia with platinum terminals. This rod is connected in series with a dead resistance, and an e.m.f. (preferably alternating) of from 200 to 600 volts is applied to the arrangement. Upon heating the magnesia rod, by a blow pipe, for example, it becomes a conductor and passes sufficient current to raise its temperature to that of intense incandescence.

In the more recent types Nernst uses a large proportion of thoria in the rod.

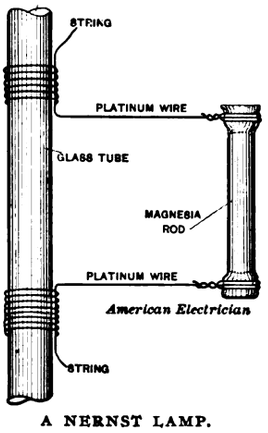
An increase of current in the lamp causes a rise in its temperature and a drop in its resistance, and, at the temperature at which the lamp is used, this drop in resistance is so great that considerably less e.m.f. is required to push the increased current through the rod, so that the lamp is unstable, and without the dead resistance the lamp would be destroyed by the excessive current that would flow through it. The efficiency of the lamp, according to tests made abroad, is about 1.5 watts per c.p., including the watts lost in the dead resistance. The lamp gives a beautiful and pleasant white light and its life is claimed to be very great.

A number of these lamps have been constructed at the physical laboratory in Bethlehem, Pa., by Prof. W. S. Franklin and Mr. R. B. Williamson. After many trials the following procedure was found to give good results: A mixture of calcined magnesium oxide (composition of mixture given below) is tamped as compactly as possible into a smooth-bore brass tube lined with two or three thicknesses of stiff writing paper. This paper should be fixed in place with a little glue and baked dry. The tube full of magnesia is then slowly baked on a metal plate over a Bunsen burner until the paper is completely charred, when the magnesia rod may be pushed out. The rod is then calcined before a blow pipe, heating it slowly and uniformly to avoid cracking by unequal shrinkage. The rod is then broken to a length of about 2½ ins. and laid upon a bed of magnesia. Two ordinary arc carbons are brought up to the ends of the rod, one carbon being fixed by weights, the other being preferably held in the hand. Several hundred volts e.m.f. are applied to the carbons with dead resistance in circuit and the magnesia rod is heated by the blow pipe until the current starts. As the magnesia rod rises in temperature it shrinks greatly, and it must be subjected to very slight end pressure to prevent the formation of cross cracks; too much pressure will cause longitudinal cracks. The current is then increased until the magnesia rod becomes slightly soft, when it may be straightened if, as is likely, it has curled up in shrinking. The rod is then allowed to cool and ground on an emery wheel to the required shape, as described below.

The most convenient source of current for the purpose of this preliminary heating and for operating the finished lamp is a step-up transformer with a rheostat in the primary circuit; a secondary e.m.f. of 1000 volts is satisfactory. This e.m.f., of course, falls off greatly when the current starts, because of the action of the primary rheostat.

The magnesia mixture may be pure calcined magnesia with a slight amount of magnesium chloride ground up with it to serve as a bond. A slight amount of soluble silicate of soda is also a good bond. The mixture should be only moist enough to pack like flour; it is better to have it perfectly dry than too moist. A lamp made of pure magnesia or of magnesia with 1 per cent or less of powdered silica, has a very high resistance and can scarcely be started with less than 1000 volts, and then with difficulty. After it is once started, however, the resistance falls so that even a pure magnesia rod will operate with, say, 300 volts per inch of length. A lamp which is very much easier to start is made by mixing from 2 to 6 per cent of pounded glass with the powdered magnesia. Perhaps a lime glass would be best for this purpose.

The magnesia rod should be about 1 in. or 1½ ins. in length, and about ⅛ in. in diameter, with slightly enlarged grooved ends; platinum wire is wound two or three times around these ends and covered with




A NERNST LAMP.

a paste of magnesia, pounded glass, and water glass (or simply water). The lamp is conveniently mounted by binding the platinum wires to the side of a small glass tube. The figure above shows the finished lamp full size.

A lamp made as above described, with about 1 per cent of pounded glass and 1 per cent of powdered silica, the rod being about 1¼ ins. long and ⅛ in. in diameter, operated on 250 volts (between platinum terminals), takes 0.8 ampere, and gives fully 175 c.p., although the c.p. has not been measured at Bethlehem. It has been found that the silicates of sodium and potassium (or perhaps simply the sodium and potassium) are slowly expelled by the heat while the lamp is in use, causing the resistance to become slowly greater.

Commercial magnesia (calcined Grecian magnesite) makes good lamps without any admixture of silica, although its resistance is rather high unless it is mixed with powdered glass.

An attempt was made to fuse magnesia into a compact mass in an electric furnace (100 amperes at about 90 volts), but it was found that the boiling point of magnesia (at atmospheric pressure) is about the same as its melting point, so that the material vaporized about as rapidly as it was melted. The operation would, no doubt, succeed under pressure. During this work with the electric furnace it was necessary to keep a close watch of the action, and a small piece of heavily smoked glass was used to screen the eyes, leaving the forehead exposed, and a severe case of sunburn was produced, although the heat on the face was not excessive.

A most striking experiment is to mount a glass tube as a Nernst lamp. A large, thin walled tube gives the best effect. Wind copper wire terminals about 4 ins. apart on a thin walled glass tube ½ in. or ¾ in. in diameter. Connect to the secondary of a step-up transformer with a rheostat in the primary. Heat the tube along one side. The current starts along a narrow strip of the glass, heats it to bright redness, and this heated strip gradually widens until the whole tube is melted down. This experiment was tried in Bethlehem with a 1000-volt secondary, but it would certainly be possible to perform the experiment successfully with as low an e.m.f. as 100 volts, and direct current would answer as well as alternating. With low e.m.f. the distance between the copper terminals should be much less than 4 ins., and, of course, a rheostat should be included in the circuit.

## AMERICAN TELEPHONE PRACTICE.

### DISTRIBUTING BOARD.

BY KEMPSTER B. MILLER.

In every central office some means must be provided for distributing the various line wires which enter the exchange to their proper numbers on the switchboard and to enable changes to be made in this distribution as required. If such provision were not made, and the line cables were run directly to the switchboard, the wires in one one-hundred-pair cable, for instance, being led to the No. 1 section, and those of another to the No. 2 section of the switchboard, and so on, it would be necessary, at any time when a change in a subscriber's number was desired, to open the cable, take out the proper wire and fasten it alongside of one of the other cables leading to the proper section of the board. The changing about of wires from one part of a board to another is a very frequent occurrence, and to do it in the manner above suggested would be entirely impracticable. To do it without a proper regard to systematic arrangement would lead to endless trouble, by producing a tangle of wires, commonly and well termed "a rat's nest."

In order to provide means for the systematic arrangement of the wires what is called a distributing board or frame is used. These assume a great variety of forms, but the principle on which they are designed is as follows: On one side of the distributing board are placed clips, suitably

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arranged, in which wires of the line cables may terminate. On the other side of the distributing board is arranged another set of clips or connectors, in which the separate wires of the switchboard cables may terminate. Supposing, for convenience, that the cables entering an exchange are twenty in number, each consisting of one hundred pairs of wires. These wires would pass through suitable office cables to the various terminals on the line side of the distributing board. Suppose further that the switchboard was arranged in twenty sections of one hundred drops each. Then twenty switchboard cables, of one hundred pairs each, would lead from the switchboard terminals to the terminals on the switchboard side of the distributing board. This brings connections from the line cables and also from the switchboard cables, in a permanent manner, to the various connectors on the respective sides of the distributing board.

The gap between the terminal of any line on the line side of the distributing board and that of the corresponding pair of wires leading from the switchboard is filled by means of "bridle" or "jumper wires." Suppose that the line circuit terminating in terminal No. 101 on the line side of the distributing board is to be connected with drop and jack No. 599 on the switchboard; then a bridle wire is run from terminal No. 101 on the line side to terminal No. 599 on the switchboard side, thus completing the circuit of that line between the switchboard drop and the subscriber.

One side of the distributing board often carries lightning arresters through which the various line circuits pass before entering the switchboard. These, however, are sometimes placed on a separate board between the line side of the distributing board and the cable heads. Test clips are also often provided on one side of the distributing board. These are usually simple forms of jacks, normally maintaining the continuity of the lines. They are, however, adapted to receive a test plug so that the testing operator may connect his testing apparatus with the line side of the circuit, leaving the switchboard side open, or with the switchboard side of the circuit, leaving the line side open, or he may merely bridge his testing apparatus between the two sides of the line without breaking its continuity.

Inasmuch as there are in a large exchange several thousand of these bridle wires, means are provided for their systematic arrangement as far as possible. The chief object of distributing boards is to bring all of the confusion among the wires leading from the subscribers to the switchboard into one small place, and then to minimize that confusion as much as possible. This is well done in the Hibbard distributing board, modifications of which are used to a large extent in the Bell exchanges.

This was designed by Mr. Angus S. Hibbard and is illustrated somewhat in detail in the accompanying figures. The frame is built up entirely of iron pipes, extending in three directions and mounted upon a hollow platform a, shown in Figs. 1 and 2. These two figures represent respectively the end and side elevations of the complete framework, a plan view being shown in Fig. 4. Vertical pipes serve as supports for the structure, and are intersected at short intervals by transverse pipes i and longitudinal pipes e, f and g extending the entire length of the framework. As a result of this arrangement channels or horizontal runs are formed for the jumper wires between the vertical and the lateral bars, and vertical channels or falls between the sets of intersecting horizontal bars. On the ends of the lateral bars i are vertical strips d and d' of insulating material upon which are arranged the terminals for the various wires in the cables and the jumpers.

The general plan by which the wires are led from the cable heads to the switchboard is shown quite clearly in Fig. 1, where H represents the cable head carrying the terminals of the line cable C. The various wires w leading from the cable head are bunched into a cable $C^2$, which enters the cable run in the box beneath the frame, and after passing in a horizontal direction to the proper insulating strip d' is led upward and fanned out, the various pairs of wires being soldered to the outer ends of the terminals on the insulating strip. The method of fanning out is shown in Fig. 3. the covering of the cable being taken off and the various pairs of wires r r being led out at intervals corresponding to the distance apart of the terminals on the strip. After being properly formed the cable is laced and varnished, after which it is strapped into place and the wires soldered to the terminals on the strip.

The details of these strips and the method of attaching the wires of the cable are shown in Fig. 5, in which p and p' are the connectors screwed to the strip d. These connectors have outwardly bent lugs u, to

FIG. 1.

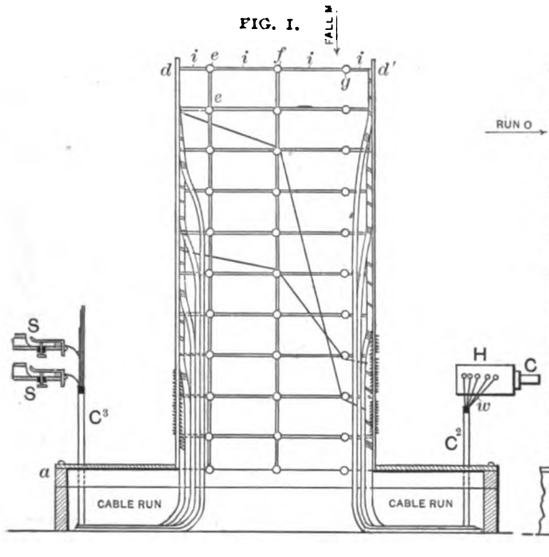
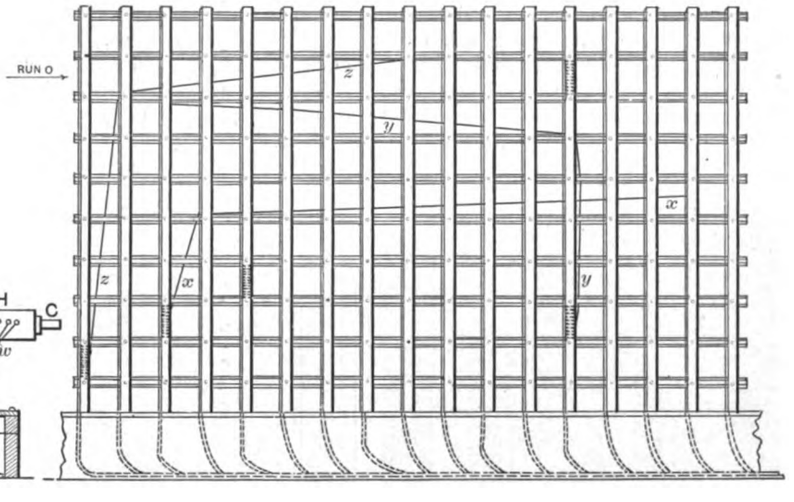



FIG. 2.



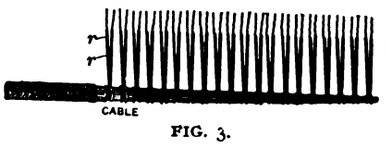




FIG. 3.

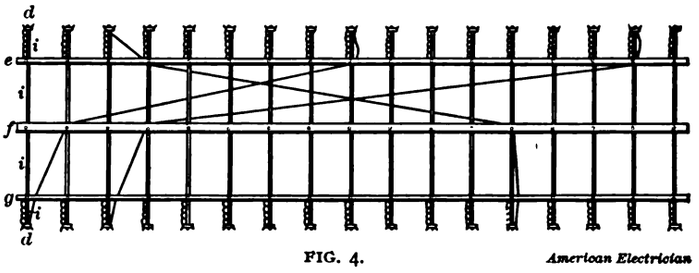



FIG. 4.

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which the wires may be soldered. The ends of the jumper wires are shown at t t'. In a similar manner the wires leading from the switchboard jack are bunched into a cable $C^s$, which is then led through the cable run and to the proper strip d of the

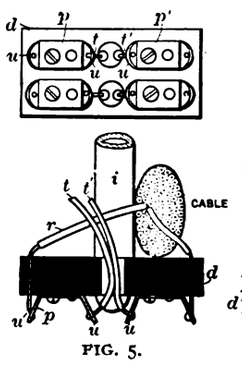



FIG. 5.

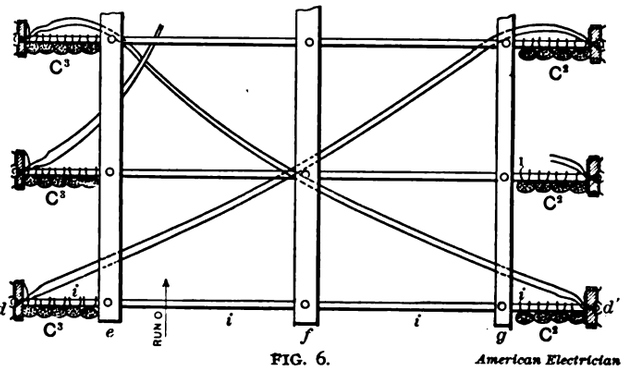



FIG. 6. American Electrician

distributing board, where it is fanned out and connected to similar terminals. The vertical portions of the cables, which are to be fanned out on the distributing board, are supported by the lateral horizontal rods i by being laced thereto, this being shown

through the proper channels in the framework to the desired terminals on the switchboard side, where they are secured in the same manner.

This arrangement serves to keep the wires fairly open and easy of access, but for very large exchanges it becomes cumbersome and has been supplanted by one designed by Messrs. Ford & Lenfest, some of the details of which are shown in Figs. 7, 8 and 9. This, like the Hibbard board, is in the form of an open framework built

carry upon one side of the frame horizontal strips 8 of hard wood upon which are secured the terminals for the wires of the street cables. A detail of these terminals is shown in Fig. 9, the metallic connectors m and n being secured in place in transverse saw-cuts in a thin strip of board by another strip bolted over them. A good idea of this general construction may also be had from Fig. 10, which shows a slightly modified construction. Supported upon the other end of the horizontal bars 6 are the vertical pieces 10 and 11 of hard wood and the flat bar 12, which is of iron. Upon this bar of iron are mounted the arresters X and Y, as shown in Fig. 8. These arresters, which are of the combined static and sneak-current type, will be recognized as the same as one of those shown in a previous article.*

In wiring this distributing frame, the street cables C are led in a horizontal direction under the strips 6, as shown in Figs. 7 and 9. These cables are then fanned out, the various pairs of wires passing through holes 14 in the underside of the horizontal wooden strip 8 and secured to the lower ends of the connectors m and n.

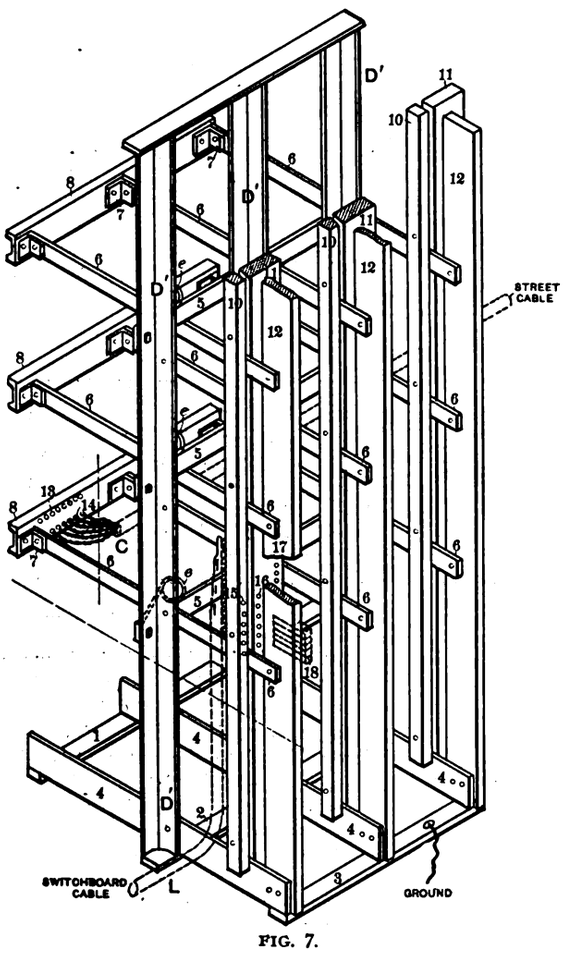



FIG. 7.

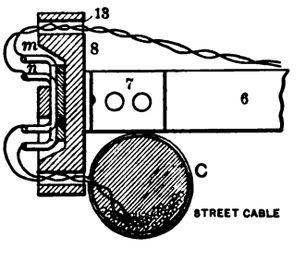



FIG. 9.

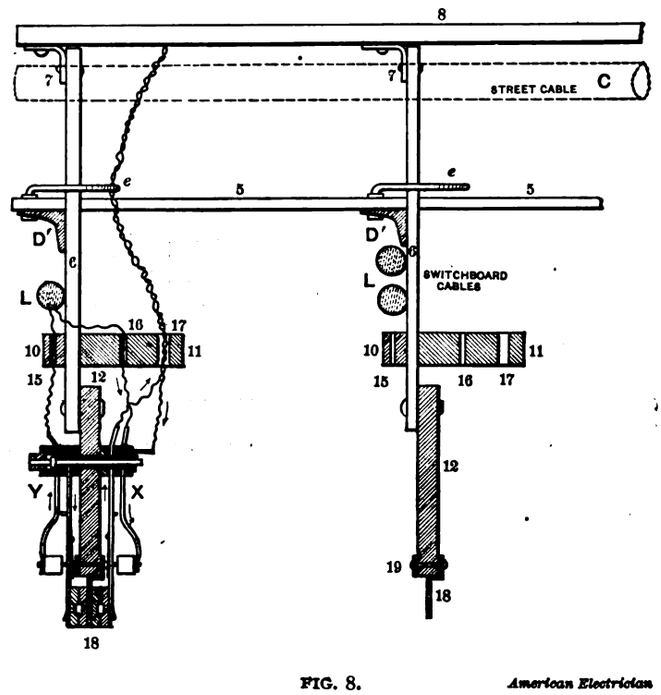



FIG. 8. American Electrician

quite clearly in the enlarged plan view of Fig. 6. The jumper wires which are usually formed of No. 22 B. & S. G. tinned rubber-covered wire in twisted pairs, are attached to the inner ends of the terminals on the line side of the distributing board and led through a hole in the strip and

chiefly of iron. Iron bars, 1, 2 and 3, to which are bolted plates 4, form the foundation of the frame. To the face of the plates 4 are bolted the supporting columns D' of angle iron, to which are secured all of the other portions of the frame. Horizontal bars 6 are bolted to the columns D' and

The switchboard cables L, shown in Figs. 7 and 9, are led from beneath up along the sides of the bars 6 between the supporting bars D', and the wooden strips 10 and 11. They are supported in this position by be-

*"American Electrician," November, 1898, Fig. 6, "American Telephone Practice."

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ing laced to the horizontal bars themselves. These cables are fanned out, the various pairs passing through holes 15 and 16 in the wooden strips 10 and 11 and to their appropriate terminals on the arresters. The

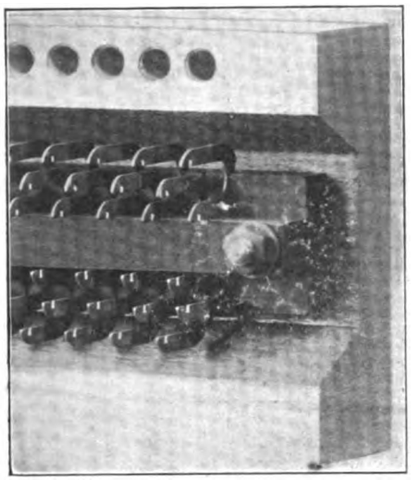


FIG. 10.

connections of the street and switchboard cables are thus as far as possible made permanent. The jumper wires are each led through a hole, 13, in the upper part of the horizontal wooden strip 8, its ends being secured to the upper portion of the connectors m and n, as shown in Fig. 9. The wire is then led in a horizontal direction along the top of the bars 6 on the line side of the frame until a point is reached opposite the vertical strip on which the desired switchboard terminal is located. It is then led through an eye or ring e and through a hole 17 in the vertical strip 11, and attached to the proper terminals on the arrester through which the connection is made with the switchboard wires.

A distributing frame built upon this general plan is shown in Figs. 11 and 12.

The line cables enter the exchange and are fanned out on the horizontal side of the distributing frame, as shown in Fig. 11. The terminals on the line side are numbered with respect to the wires in the cables to which they belong. On the vertical side of this board, which is shown in Fig. 12, are placed the arresters, to which lead the wires from the switchboard cables. The jumper wires connecting the horizontal with the vertical sides are arranged as already described.

In this exchange and in many others of the more modern Bell exchanges, the wires from the vertical side of the distributing frame do not pass directly to the switchboard, but to an intermediate distributing frame which is similar to the one shown, with the exception that the arresters are left off. After passing through this intermediate distributing frame the cables are again formed up and led to the switch board. At the main distributing board all of the changes are effected which are made necessary by the change in the location of the subscribers, by the addition of new subscribers and the loss of old ones. The function of the intermediate distributing board is to permit of the rearrangement of the lines upon the switchboard, in order that they may be grouped to the best advantage for quick service. By it the number of calls received per hour by the various operators may be practically equalized so that a part of the operators will not be overworked, due to having an undue proportion of busy lines.

The distributing board manufactured by the Western Telephone Construction Company for some of its larger exchanges is shown in Fig. 13. The side shown in this figure is the line side, to which the line wires from the cable heads are run. Each of the vertical strips seen in the lower sec-

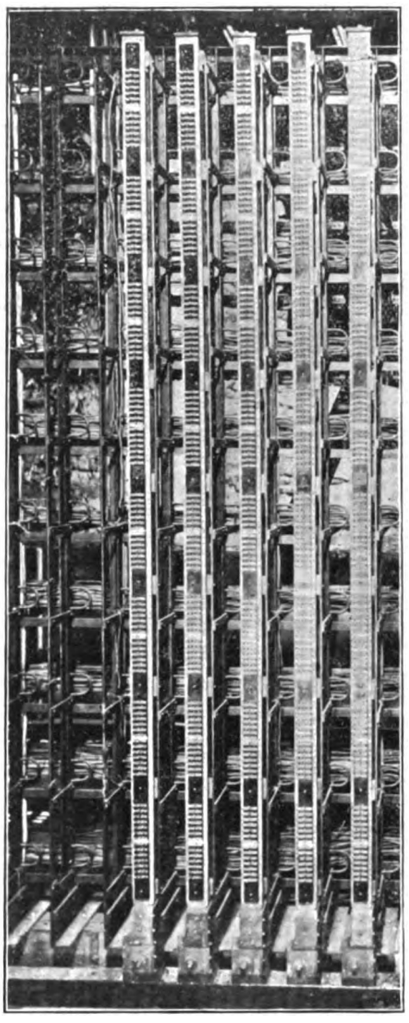


FIG. 12.

tion of the structure contains lightning arresters for twenty-five metallic circuits. These arresters consist merely of delicate fuses with suitable clips for holding them. Each strip is provided with a ground plate coming into close proximity with the various clips, so that a high tension charge may find passage to the ground. The cables leading from the cable heads of the outside lines are afforded room in the box or trough underneath this structure and each one is bent upward when opposite the proper pair of strips and then fanned out and permanently connected to the appropriate clips on the lightning arrester strips. All of these connections are made permanent.

In like manner the cables leading from the switchboard are brought into the same trough and bent upward through holes in the baseboard on the opposite side from the line cables, and are then fanned out and connected to the test clips, which are arranged on similar vertical strips to those containing the lightning arresters. These connections are also made permanent. Each jumper wire is run from the proper clips on the arrester side under the nearest one of the horizontal wooden rods shown on the interior of the lower part of the structure, and then bent upward so as to pass through a hole to a rack above. Inasmuch as the wire is to go to a certain terminal on the switchboard side it passes through a corresponding opening in the rack and thence in a horizontal channel, formed by the outwardly projecting pins, until it is opposite the terminal to which it belongs on the switchboard side of the board. Here the pair of jumper wires again passes through the vertical rack and down through a small opening and under one of the horizontal rods below, after which it is soldered to the proper pair of terminals. This com-



FIG. 11.

pletes the connection from the outside line to the switchboard line.

The test clips on the opposite side of the boards and lightning arrester clips are of heavy German silver springs arranged for

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the insertion of a double plug in such manner that the testing apparatus may be connected in any desired manner to any line.

The best wire to use for jumpers is No. 20 or 22 B. & S. G. tinned, rubber covered, twisted in pairs. It is convenient to have the two wires forming a pair of different colors, so as to distinguish between the tip and sleeve sides of the line.

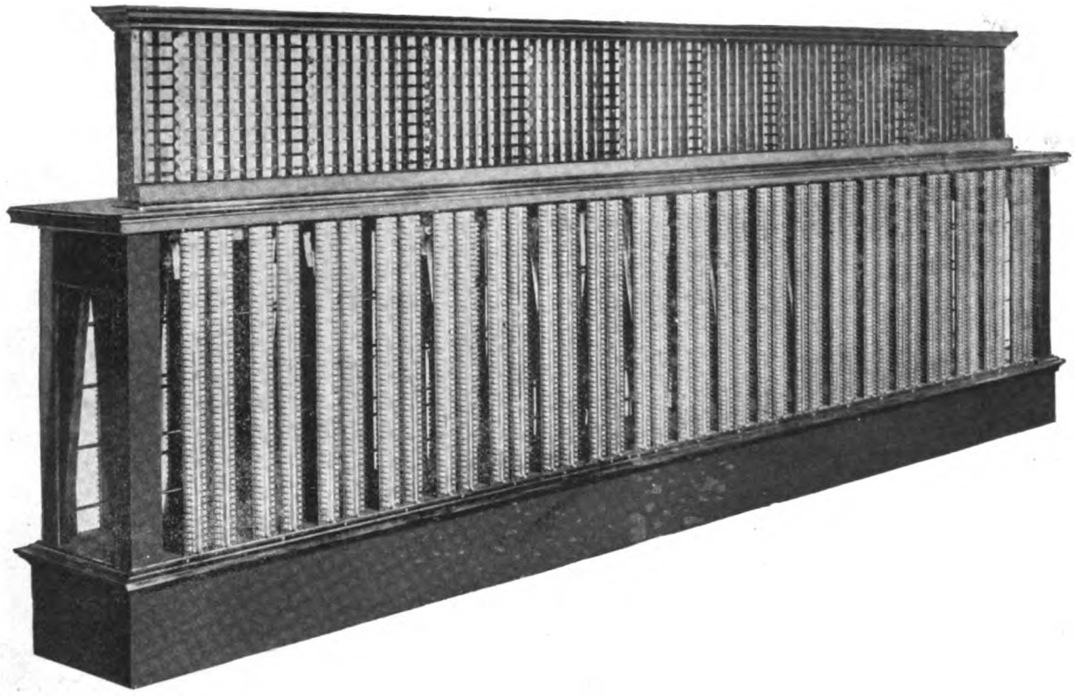


FIG. 13.—AMERICAN TELEPHONE PRACTICE.

## INTERIOR WIRING.

### STARTING THE INSTALLATION.

BY CHAS. E. KNOX.

In all the previous articles in this series, we have considered the subject of interior wiring from the standpoint of the person preparing the plans for the wiring installation. We have considered and discussed the various problems, which present themselves in "laying out" the outlets and lights and planning the circuit work. It now behooves us to change our point of view, and consider the subject from the standpoint of the contractor installing the work.

We will not stop to discuss methods of getting contracts, which, while interesting from the financial standpoint, are not equally so from an engineering view. We will suppose that he did get the contract by hook or crook, by merit or influence, and pass on to the trials and tribulations which he will meet in the performance thereof.

In taking up this portion of the subject we will introduce for consideration the various kinds or makes of conduits, insulators, wires, panel boards, switchboards, etc., and methods for their installation. In connection with these, cuts and drawings of the materials and appliances will be given as well as photographs of actual installations. Recent improvements and innovations will also be shown and their merits and defects pointed out. Examples of electric light installations in old buildings in which no provision for electric lighting was made at the time the building was put up, will also be given.

The first question which arises in regard to the installation of the work in a new building is, at what stage of the erection of the building should the electrical work be started? If the circuit work is to be exposed on insulators it can be commenced at any time after the building has reached the point when proper support for the insulators may be obtained. It is not well to commence putting up the wires too soon, however, as they are frequently used by other workmen as means of support. I know of an instance where large conductors on insulators were actually used in lieu of scaffolding by the steamfitters working on the same building, to the great indignation of the foreman in charge of the electric work.

If the circuit work is to be concealed, it must necessarily start before the flooring is laid and before the plastering is commenced or, in case of a frame building, before the lathing is put on. Experience has shown, however, that it is a mistake to start the conduit work before the partitions are set, for the reason that when this is done, it frequently happens that the partitions are shifted slightly from the location shown on the plans or there may be a discrepancy in scaling the plans by the different workmen. Again, if the work be started too soon, loss of the workmen's time ensues, owing to the lack of definite information as to exact location of outlets, distributing centers, allotment of space, etc. If, on the other hand, the work be started too late, the space provided for the electric work (particularly the "risers") is very apt to have been appropriated by some of the other trades. Also the amount of cutting and patching which must be done is greatly increased.

Sometimes the conduit work for the branch circuits is installed before the sleepers are laid. In this event the carpentry contractor has to notch the sleepers for the conduits, instead of the electric-wiring contractor. While this procedure has its advantages from the standpoint of the latter, it is objectionable from the standpoint of the owner, because if any changes have to be made afterward in the conduit work, the cost of the changes is increased, as the sleepers must be cut all the way through in order to raise the conduits (the latter being under instead of being laid on the sleepers) or else the conduits must be abandoned entirely and new ones run in the required direction.

A limited number of men (say two or three) should be put on the work at the start, in order to let the foreman get the "run of the work," for otherwise the men will be principally occupied in filling in time (and incidentally their time sheets) waiting for instructions. Before the work is actually commenced, information should be obtained on the following points: Height and exact location (as far as possible) of outlets, switches, distributing centers, etc., and, if the building is to be piped for gas, at what outlets combination fixtures are to be provided. If outlet boxes are used a sample of the gas "L" should be obtained to be used as a guide in ordering the outlet boxes for the side brackets so that the holes for the screws fastening the "L" to the box will be drilled in the right manner and the proper distance apart; also, it should be determined if any modifications have been made in the building which will affect the electric work, since the plans for the structure were made; conferences should be held with the representa-

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tives of the other trades in order to anticipate any trouble which might otherwise arise from the work of one trade interfering with another.

Of course there are numerous other questions which occur peculiar to each case which should be settled before the work is started. While all the above points are minor details and may not seem worthy of the attention given them, it is just such trivial things which cause trouble. A little foresight at this stage of the work will save a great deal of trouble, annoyance and expense later on in the work.

Now as to what part of the work should be started first, it will be found that this is generally settled by the circumstances of the case. Where this is not so and the contractor may choose, it would probably be better in the majority of cases to commence with the feeders and mains. It is harder to find suitable space for the large conduits, and even if a particular space be set aside for them, this space is always liable to be seized for the overflow of the steamfitting, plumbing or other work requiring similar space. But if the feeders and mains are put in first, the other trades will be forced to accommodate their work more or less to the electric work, instead of putting all the burden on the electrical contractor.

It should always be borne in mind that the architect's cardinal idea of electrical work is embodied in a "flexible cord." He seems to think that while the plumbing and steam pipes, ventilating ducts, etc., require actual space, the electric work may be "tucked" in anywhere and sometimes has a poor idea of the electrician's ability because the latter has to give up a problem which is as impossible of solution as getting an "elephant in a cigar box." This idea is, however, gradually disappearing and the electric work will soon be treated in this respect in the same manner as the rest of the equipment of a building.

In the next issue the installation of the feeders and mains will be taken up.

## THE THAWING OF FROZEN WATER PIPES BY THE ELECTRIC CURRENT.

The use of electric current for thawing frozen water pipes, especially service branches in inaccessible locations, was brought to the attention of the public through the newspaper accounts of some experiences of this kind carried out about March 1st by Professors Jackson and Wood, of the University of Wisconsin. Since then the subject has excited widespread attention and considerable data has been given as to the voltage and current necessary in individual cases, a general resumé of which may be of interest.

In the first place the current required is far greater than that of arc light circuits, so that there is little hope of accomplishing anything with the 10 amperes that can be derived from them. On the other hand the voltage needed is so low that if street railway power is used an enormous amount of it is necessary, fully nine-tenths or more of which is not only thrown away but requires cumbersome apparatus for its absorption. With 110 volt isolated plants of sufficient dynamo capacity good work can be accomplished and the application of the current is of such short duration that no fear need be felt of electrolysis. Where such plants are available and are not in constant use, being shut down through the day, the current strength can be very simply adjusted by varying the field strength of the dynamo, and no water rheostat or other resistance need be used. With Edison 220-volt systems attention must be paid to the grounding of the circuit at other points. Many such systems have their neutrals permanently and heavily grounded so that any currents drawn into underground water pipes must be taken from one side of the system. The unbalancing effect of the heavy current necessary for thawing water pipes is so great that an equal load should be applied to the other side of the system at the same time.

The best source of current is an alternating system, especially as the temporary wiring for this purpose can be put in the primary circuits, the transformers being located close to the frozen pipes, and comparatively small wires can therefore be used. A secondary pressure of 50 volts will be sufficient for all ordinary cases. One odd result of the use of alternating currents in this way has been reported from a town with a ground return telephone system, where the alternating potential difference applied to the water mains promptly called

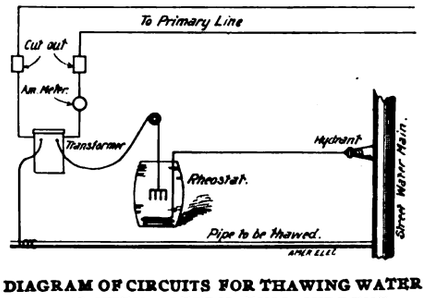



DIAGRAM OF CIRCUITS FOR THAWING WATER PIPES WITH ALTERNATING CURRENT.

up every subscriber in town and caused quite a flurry at the central exchange.

The general arrangement of the circuits is best shown in the accompanying drawing representing a frozen service from a street main. One lead from the secondary of the transformer is connected to the piping inside the dwelling house or other structure to which the service leads, and the other terminal of the transformer secondary is connected through a water rheostat with the street main, either via a convenient hydrant or a service branch to neighboring premises or any other point of access. Care should be taken that the water piping within the house affected is not crossed with other pipes such as gas pipes, etc., which might give another outlet to the street mains. If the piping of the premises is elaborate and heavily grounded, it would generally prove best to cut it off from the service.

The following reports give some idea of the amount of current necessary for different cases: Messrs. E. A. Britton, A. R. Welch and G. Lighthall, of Chelsea, Mich., thawed a house connection of 80 ft. of 1-in. pipe with 180 amperes applied for 14 minutes. Current was taken from a 100-k.w. 220-volt direct-current generator and controlled by a water rheostat made of an ordinary barrel filled with salt water, a coil of bare copper wire in its bottom, forming one terminal, and a bundle of seven common arc lamp carbons hung from a piece of line wire forming the upper and adjustable terminal. The same gentlemen thawed out two house connections at once, the houses being on opposite sides of the street and connections made to the respective sill-cocks of the two houses. One hundred and sixty amperes were used in this case.

F. H. Soden, of Chicago, thawed a 1-in. pipe, the circuit containing 110 ft. of lead pipe of this size and 45 ft. of 6-in. iron pipe. The current used was 155 amperes at 25 volts. Water began to flow in seven minutes. Alternating current was used in this case and controlled by a reactive coil in the primary circuit. In another case a ¾-in. lead pipe required 190 amperes, the voltage necessary to force this through 85 ft. of the lead pipe, and 22 ft. of 6-in. iron pipe being 30 volts.

Mains have been thawed in some cases; in one instance a 6-in. main required 350 amperes, the length in circuit was 320 ft. and 100 volts alternating current were used. Professors Frederick Bedell and G. S. Moler report the thawing of a 4-in. cast iron main on the campus of Cornell University, Ithaca, N. Y. A current of 160 amperes was maintained for 5 hours and 40 minutes in this case and was supplied by a 220-volt low pressure alternator. This was run with only 12 volts across the terminals, of which 9 volts were delivered to the water pipe.

## UNIQUE USES OF THE ELECTRIC CURRENT.

One of our English contemporaries cites the uses of electricity to liven up a dancing bear. This peculiar adaptation of the principle that "electricity is life" was made public by the claim of an electrician for work done in fitting up an electrical table on which the bear was to dance, the owner refusing to pay on the ground that the current was not sufficient to have the intended effect. There is obviously an opportunity here for a special course of instruction in the institutions of electrical education.

A physician of Wiesbaden has discovered that the application of electricity will cure the bites of insects, such as the Jersey mosquito and the elusive flea, as well as the more serious wasp and hornet. According to accounts, a direct current should be used and the negative pole put in contact with the place stung.

Still another application, somewhat out of the ordinary, has been proposed by the Board of Health of Newport News, Va., the suggestion being to surround the local pest-house with a barbed wire fence, the wires to be charged with a sufficiently high pressure to discourage attempts at escape, but insufficient to do serious physical damage.

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## STEAM AND WATER STOP VALVES.

MISCELLANEOUS.

There are many valves in use that are neither gate, globe nor plug, yet they are well adapted for the duty they are called upon to perform. A very good form of the improved plug valve is shown by Fig. 1. The valve carries a double cap and

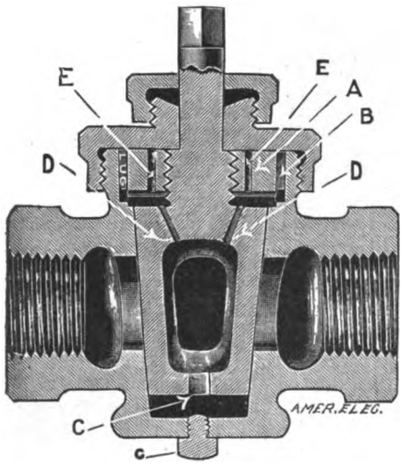



FIG. 1.—HOMESTEAD STRAIGHTWAY PLUG VALVE.

also contains a traveling nut, marked A in the engraving, which raises the plug from the seat when the valve is opened and also carries lugs which limit the travel of the plug to one-quarter turn, this being sufficient to give full opening or full closing of the valve.

This valve is made by the Homestead Manufacturing Company, and is constructed in either brass or iron. The plug is made with ports C D D E E for the purpose

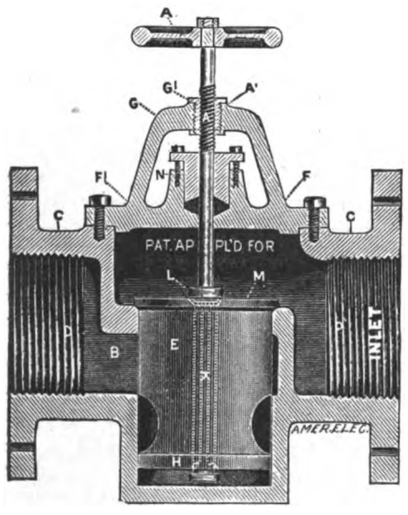



FIG. 2.—HENNEBOHLE'S BALANCED VALVE.

of equalizing the pressure on the two ends of the plug, thereby allowing it to move easily when opened or closed without the possibility of sticking to its seat. There is a screw plug in the bottom of the valve casting which may be removed whenever it is desired to drain the valve or to remove any sediment that may have collected. This valve is such an advance upon the crude constructions that have and still do duty as plug valves, that many of the prejudices against that ancient form of valve must be removed as soon as this form becomes familiar to engineers. For the engraving and description of this and several other valves in this article, we are indebted to "Power," from the pages of which the items in question were reproduced.

Another outgrowth of the old-fashioned plug valve is presented by Fig. 2, in the shape of Hennebohle's balanced valve. The engraving shows the construction so plainly that but little description is necessary except to state that when the valve is to be opened the hand wheel is turned just enough to allow steam to pass through the center of the valve until the pressure is equalized, then the valve may be easily opened to its full extent.

The stuffing box under the yoke, together with the bearing in cap and yoke air well form ample bearing surface for the valve stem, while the body of the valve sup-

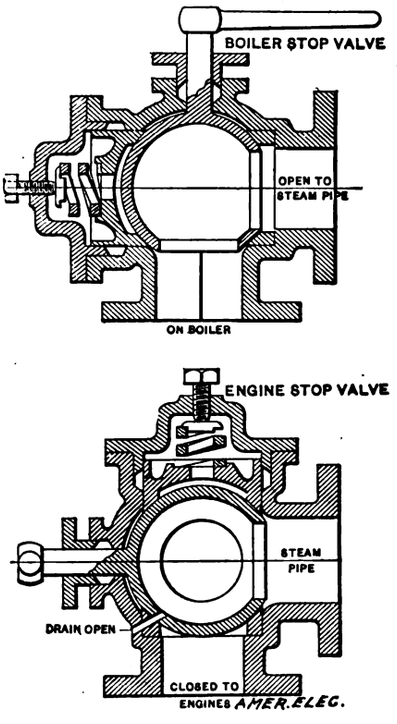



FIG. 3.—SPHERICAL BALANCED VALVE.

ports the cylinder or disc in a very thorough manner. This valve was patented by F. Hennebohle.

A valve, which is designed to withstand any pressure which the material will admit, is illustrated by the two engravings comprising Fig. 3. This is not a globe valve, neither is it a gate nor a plug; yet it is a modification of the latter with about all the poor points eliminated therefrom. The valve is balanced by the application of the balance plate shown in the engraving, in which openings are provided suitable to correspond with those in the globe.

When the valve is closed all the steam and water of condensation from the body and passages in the valve run to the condenser or to the drip, thereby preventing all possibility of explosion from confined steam or water. This valve may be made applicable to any degree of pressure when applied to hydraulic machinery, by adjusting, through the coiled spring as shown, the pressure screw which bears against the balancing valve or plate. This valve is the

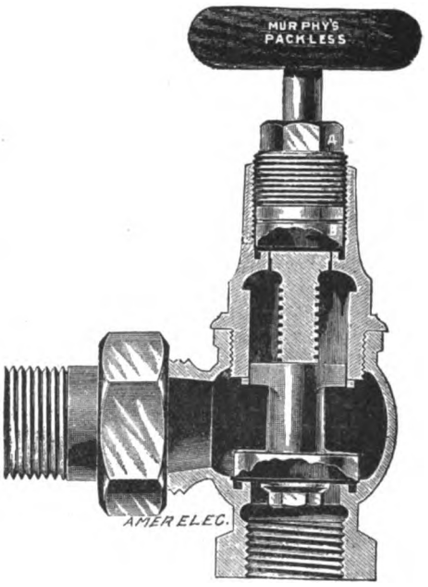



FIG. 4.—MURPHY'S PACKINGLESS VALVE.

invention of an English engineer, Mr. James Casey.

A type of valve known as "Packingless" is on the market, placed by several makers. The Murphy Packingless Valve, illustrated by Fig. 4, is one of this kind. It is not to be understood that there is no packing between the disc and seat of these valves, but between the stem and the gland this paint is made tight by the disc B in the

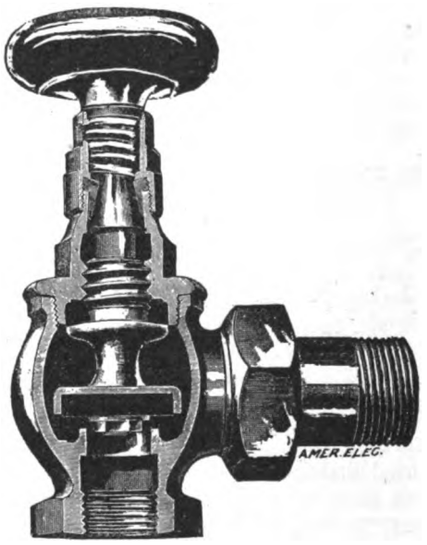



FIG 5.—MORIN PACKINGLESS VALVE.

neck of the valve, the nut A being used for adjusting the disc B.

The peculiarity of this valve is, therefore, that the loose neck packing usually placed around the stem of a valve is replaced by the disc on the stem which carries a ground surface against which an ordinary packing ring bears, in a manner similar to the reg-

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ular disc packing in ordinary valves. The nut under hand wheel need only be adjusted just right and the valve is packed tight or loose as desired. This valve is made by the Van Auken Steam Specialty Co.

Another so-called "packingless valve" is illustrated by Fig. 5. It effects the same results as described above, but in a slightly different manner. This valve is known as the Morin Packingless Valve and was placed on the market by the McNab & Harlin Company. It is understood that two styles of this valve are made, one with a double core disc which may be reversed when one side is worn out; the other style, which is the one shown in the engraving, carries the regular Jenkins seat.

That portion of the disc which carries the thread is loose in the valve, and is only attached and guided by the thread in question. The stem is square in section, and enters a square hole in the disc, which slides up or down upon the stem when the latter is turned one way or the other. Just above the square portion of the stem may be seen a core which forms part of the stem, and is kept pressed into the cap or gland by the force of the coiled spring, shown above it.

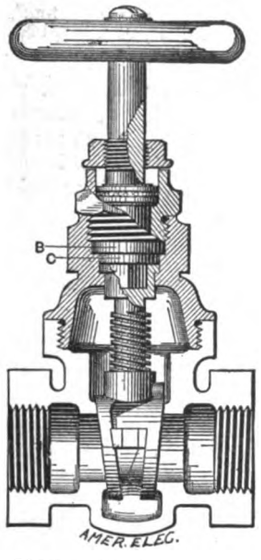



FIG. 6.—COOK PACKLESS BALL BEARING VALVE.

The pressure of the spring keeps the stem core at all times tight against a conical seat in the cap so that there is no leakage whatever. As the steam or water pressure increases, the pressure against the conical seat also increases. This is caused by the area of pressure against the lower end of the valve stem.

There is also a projecting ring to be seen on the upper portion of the disc, which engages the bonnet when the valve is fully open. This allows the cap or gland to be removed when the valve is fully open, taking with the cap the stem, spring and conical seat, without leaking steam in the least. The valve may also, of course, be opened, as above, when fully closed.

Still another form of "packless" valve is shown by Fig. 6. It is known as the "Cook Packless Ball Bearing Valve," and was invented by J. J. Cook. This is a gate valve with a packed disc B, which is reversible and works against the disc C, attached to the valve stem and held in place by a jamb nut, in the upper portion of which is a circle of steel balls caged between two steel plates, thus eliminating all friction, except that of the packless joint.

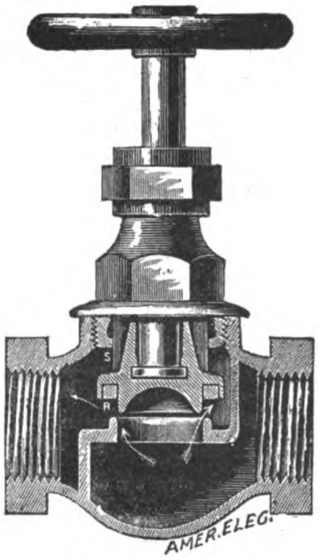



FIG. 8.—THE LOCKE VALVE.

This gate valve is of the "loose wedge" variety, whereby there is little or no scraping of the gate and seat surfaces over each other. The packless joint is kept tight by means of the nut on the upper part of the valve stem, which can be tightened without fear of working loose, as the collar on top of the upper plate has a lug on its interior surface which fits into a slot in the valve stem and must therefore revolve with it. By drawing the disc on the lower part of the stem firmly against the disc B, steam is prevented from leaking around the valve stem.

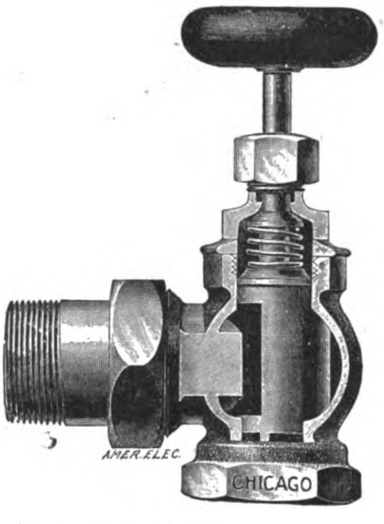



FIG. 9.—CHICAGO HOT WATER RADIATOR VALVE.

A form of valve is shown by Fig. 7, which is of the globe variety, and is so designed that the seat may be easily turned up with a file by simply removing the bonnet. As seen in the sectional view A, and the plan C, this valve is provided with a cylindrical seat which projects above the body of the valve when the bonnet is removed. It is also claimed that the annular construction of this valve seat makes it impossible for heat to distort or spring the seat so as to cause leakage.

The course of the fluid through this valve is not very direct, but it is claimed that for a majority of purposes this disadvantage is more theoretical than practical. Another good point in this valve is the lug shown in cuts A and B, through which a bolt is placed to hold together the bonnet, which is split through the thread at this point. It is very hard to remove the bonnet from a valve which has been exposed to the heat for a long time, but by loosening the bolt, the split bonnet opens a trifle, permitting it to be readily unscrewed. This valve is the invention of C. M. Callanan.

A valve, which has been designed to protect its soft metal packing, is illustrated by Fig. 8, and is known as the Locke Valve, being manufactured by the Locke Regulator Company. In this valve the disc is readily removable, and is fitted with an annular channel into which some soft metal is cast at R. A projection of the disc passes inside the opening in valve seat and takes the wear of the fluid away from the soft metal ring, especially when the valve is nearly closed or is just opening. The upper part of the disc is fitted with lugs and extends up into the bonnet, thereby forming all the guidance that is necessary for entering the disc into the seat.

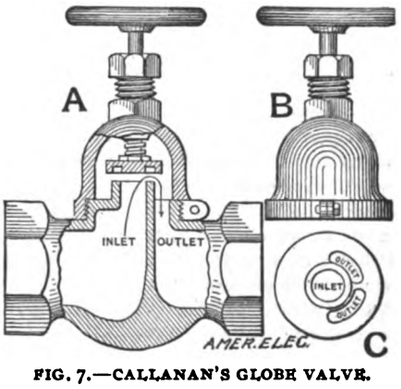



FIG. 7.—CALLANAN'S GLOBE VALVE.

A valve, which is in considerable use upon radiators, is illustrated by Fig. 9. This valve has some characteristics which are very useful. Among them is that of being packable without shutting off the water.

The disc of this valve is cast of brass, and has a by-pass which assures perfect circulation at all times. The construction of the valve is so plainly shown by the engraving that no further description is necessary. This valve is made by The Roe Stephens Manufacturing Company.

Two valves made by The Crane Company are illustrated herewith by Figs. 10 and 11. The first is a quick opening steam radiator valve which opens with a quarter turn of the lever. The stem of this valve simply rotates instead of rising, which goes

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far toward preventing a leaky stuffing box. The vulcanized rubber with which this valve is packed, and also the material which is used in other valves for a similar purpose, will expand in a different ratio from the metal of which the body of the valves is composed. This, as many people have found to their sorrow, permits the valve to leak after it has cooled down to normal temperature. To prevent this leakage a spring has been placed in this

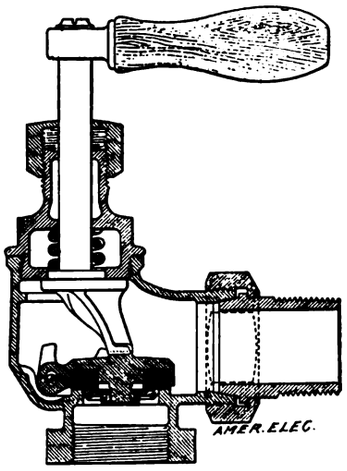



FIG. 10.—QUICK OPENING STEAM RADIATOR VALVE.

valve of sufficient strength to close the valve against the pressure it is likely to have to stand. Thus when the valve is closed the spring is compressed more than enough to allow for all possible contraction of the packing washer. In this manner the valve must remain tight, no matter how much the packing may shrink.

Again, with the ordinary form of valve, it may not be quite closed when a person

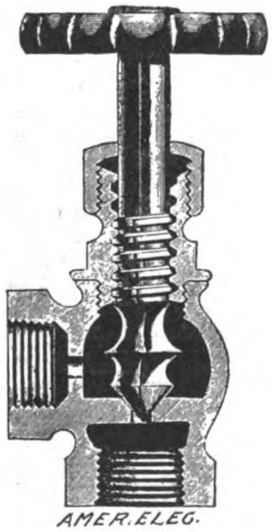



FIG. 13.—NEEDLE POINT ANGLE VALVE.

turns down the hand wheel, and then the radiator fills with water and thumps badly when steam is turned on again. With the valve here described it must be either fully open or fully closed, so that the kind of leakage above described cannot occur. The spring will close the valve tight if the lever is depressed enough to close it at all, otherwise the spring will keep the valve fully open.

The other valve alluded to in a preceding paragraph is a quick opening valve for a hose connection. This valve also is fully opened or closed by a quarter turn of the lever. The construction is virtually the same as that of the preceding valve, with the exception that the valve is made positive by removing the spring. This valve gives practically a full opening of the pipe, and is virtually a straightway. There is the smallest possible surface to corrode in this valve, a point which is of value in hose connections which must necessarily be exposed to the weather all the time.

A form of globe valve is illustrated by Fig. 12, which is in use considerably for controlling the flow of oil to an oil-burning furnace or burner. Outwardly the valve has the appearance of an ordinary globe, but the seat casting extends entirely across the interior of the valve and is pierced by the small hole as shown. This

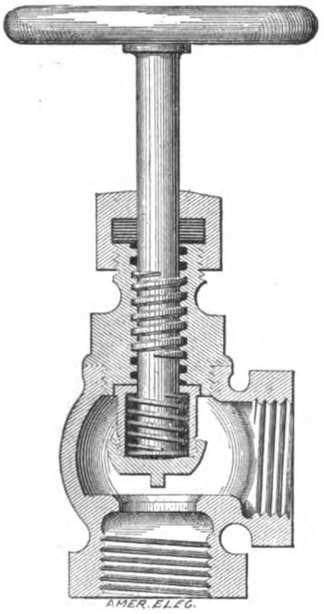



FIG. 14.—DODGE'S AUTOMATIC VALVE.

valve is made by the Haydensville Manufacturing Company, and is tested up to 100 pounds. The seat is reamed out a little when the valve gets to leaking, and the needle point may be put in a lathe and trued up whenever necessary.

Another form of needle valve is illustrated by Fig. 13, and is of the angle form. It is a product of The Crane Company. A feature of this valve is the placing of a second web in the end of the tapping hole leading to the horizontal opening. This strengthens the valve a great deal and admits of its being made somewhat thinner than otherwise would be permissible. The metal around the valve seat can also be relieved a great deal of the cutting action of the stream of oil by making the hole through the vertical diaphragm smaller than the hole where the needle works. Thus the needle seat will keep in shape for a much longer time than where there is only a single hole as in the globe needle valve.

A peculiar and very convenient form of valve, which, though not strictly a stop valve, may well be considered as such, is shown by Fig. 14. This valve is intended for an automatic cylinder cock which will work while the engine is running, and which may also be used at will as an ordi-

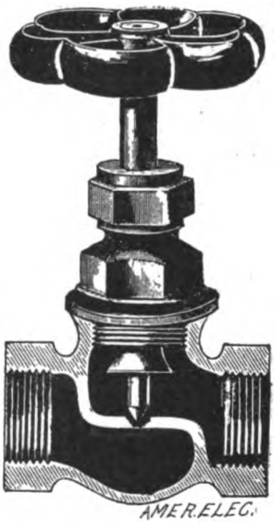



FIG. 12.—NEEDLE POINT GLOBE VALVE.

nary globe valve. The engraving shows the disc held up by a spring. When steam pressure is put into the cylinder the spring is compressed and the valve closes. This happens when an engine takes steam at the beginning of the stroke. When the engine exhausts the spring opens the valve again and any water of condensation that may be in the cylinder can run out. The spring can be so delicately adjusted that a very slight increase of pressure in the cylinder

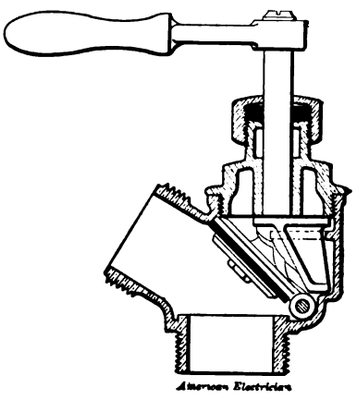


FIG. 11.—QUICK OPENING HOSE VALVE.

will close the valve. It is claimed that many accidents resulting from water in the cylinder would be obviated by the use of this valve, which does not require that the water shall be under great pressure in order to be forced out of the cylinder, as is the case when the ordinary relief valves are used. This valve was invented by John S. Dodge.

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## ECONOMY OF STEAM PRODUCTION.

BY A. L. HARRISON.

When one notes the improvements made in the engine room and the way in which every detail is made in accord with the most advanced knowledge of the principles involved and of the most intelligent practical utility, and then looks in the boiler room there is a contrast which is astonishing.

It is true there has been improvement, but there still remains so much evident room for further improvement, especially in details, that one necessarily wonders why this important factor in the production of heat, light and power has not received its share of attention. That it has not is painfully evident in the majority of boiler rooms. The boilers in use at the present time are, for the most part, of good general design, but there is an evident lack of attention to special practical requirements.

This lack of intelligent adaptation is, I think, due in a large measure to the practice in making specifications for and in the purchase of boilers. There are some notably commendable exceptions, but the great majority of architects, even at this late day in designing a large building for business purposes, are lame in respect to the steam plant. If an architect, when proudly showing his plan for an important hotel, office or other business structure, is asked where he is going to put the plant (upon which, in a large measure, the economy and comfort, if not the success and usefulness of the building depend) the usual reply is, "Oh! that goes in the basement," and in consequence great difficulty is experienced in placing the necessary equipment because no intelligent provision has been made for space to place the various appliances required.

This is true not only of the older buildings into which a modern equipment has been introduced, but of many of the most modern and pretentious buildings in the various cities. There is one firm of world-wide reputation as designers of modern large office structures who cannot point to a single one of the fine, large buildings designed and built under their supervision where the steam plant is not a disgrace to the profession. This firm, like many others, never "points with pride" to the intelligent knowledge displayed in the arrangement of the basement. Their pride is that part above the ground.

Boiler manufacturers are behind in a similar manner in respect to the furnace, which is a basic factor in the successful operation of the boilers. They design the heating surface with a view to strength, durability, circulation, separation and advantageous application of heat, but take no such pains as to arrangement and adaptation of a furnace. As a consequence there are not a few large modern boiler plants from which full capacity cannot be practically realized, because no adequate grate surface can be arranged or placed so as to burn the necessary amount of "steam coal." I know one very large boiler plant in a Western city where oil is now being used for fuel at a cost which would ruin any concern not having a monopolistic profit, because the furnaces are so arranged that getting "full duty" with coal is a practical impossibility. The boiler company's design provided a furnace nine feet deep and with four fire doors across the front. Think of a fireman trying to clean or to keep that grate surface well covered, the rear end of which is twelve feet or more from where he must stand to do his work! Think of his trying to "hold" steam with one of those doors necessarily open nearly all the time, admitting almost constantly a great volume of cold air into the fire chamber!

There is also a large plant in New York where "double deck" boilers of 500 h. p. rated capacity have been installed and more of the same form and size are to be added. These boilers are 10 feet 10 inches wide between walls. If there is 5,000 feet of heating surface in each boiler (no such boiler should be rated on less than 10 square feet of heating surface to each horse power) and as economizers are placed in connection with these boilers, there should be a ratio of 1 square foot of grate to each fifty of heating surface. This grate, therefore, should be not less than 9 feet deep to work the boiler strong and secure suitable benefit from the economizers. Surely such engineering can hardly be termed an embodiment of wisdom.

Consulting engineers and architects who make specifications for and the purchasers who buy large boiler plants often leave so important a feature entirely to the contractor. They simply specify that proposals must state the evaporating efficiency that will be guaranteed. Then, when in practical operation, the owner is disappointed he wonders how it is that he has been fooled. The fact is he has not been fooled. He has fooled himself. His specifications and guarantees are a farce. Guarantees as to capacity which do not include restrictions as to temperature of escaping gases practically only guarantee that if the boiler be crowded hard enough a certain maximum horse power can be developed. The usual guarantee of a certain economic evaporation only guarantees that, with the best of fuel and while operating under the most favorable conditions, a certain economy can be shown. When it comes to everyday work with ordinary "steam coal," neither such capacity nor such evaporation per pound of fuel is realized. The boilers, however, have fulfilled the guarantee.

If any of the standard make of boilers have the requisite water heating surface with a suitable ratio of grate surface of suitable design to properly burn the requisite amount of "steam coal," satisfactory economical and capacity results can both be realized.

When the requirements of purchasers are made definite and embody the proper practical details, guarantees of economy and of capacity can be dispensed with and satisfactory results will follow as naturally and as surely as water unobstructed will run down hill. If you want capacity secure the proper heating surface accompanied with the necessary ratio of grate of suitable form. If you want to use cheap or soft "steam coal" without committing a "smoke nuisance," buy a form of furnace that can burn such coal in suitable quantity without making smoke.

In a future issue I shall try to give a description, accompanied with illustrations, of one of the best examples of intelligent selection and arrangement of an "up-to-date" boiler plant.

## ELECTRICITY AT HIGH PRESSURES.

A discourse on this subject was given by Prof. Elihu Thomson before the New York Electrical Society on March 29th. While the treatment of the subject was as a rule elementary and popular in character, some new ideas were advanced and one new machine was described and exhibited in public for the first time. The object of this machine is to obtain very high electrical pressures, unidirectional in character, that is not alternating, and with calculable voltages. Several scientists, among them Prof. Trowbridge of Harvard University, have utilized several thousand primary cells in series with each other, giving steady direct potentials which can be multiplied in various ways.

Professor Thomson's machine is based on a combination of the selector device designed by Mr. Hermann Lemp for giving unidirectional currents to Crookes tubes and the historical Planté rheostatic machine. The new combination consists primarily of a rotary converter driven by direct current at perhaps 110 volts and giving alternating current at some 70 volts, which is then transformed up by an ordinary transformer to a high pressure—15,000 volts in the case of the machine exhibited. The rotary converter also drives a large revolving frame of wood, carrying contacts, which, from time to time, connect a battery of eleven condensers in multiple with each other and across the high tension side of the transformer. The gearing is so arranged that this connection is made and immediately broken at the instant when the alternating e.m.f. is at a maximum, which is about 20,000 volts if the effective pressure is 15,000. The connection is only made when the current tends to flow in one direction, there being no contact at the peak of the opposing wave, but at the time of this peak the frame makes contacts which connect the eleven condensers in series with each other, giving a total difference of potential of over 200,000 volts.

The action is of course intermittent, the charging connections in parallel alternating with discharging connections in series. Another contact can be mounted on the same frame which will at the instant of discharge connect the eleven condensers in series across another condenser. This condenser will then receive at every revolution a cumulative charge until it becomes charged up with the full potential difference of the eleven condensers in series.

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# Lessons in Practical Electricity

CALCULATION OF ALTERNATING CURRENTS.

In the preceding article it was shown that if we lay down in the form of curves the inductive and resistance e.m.f.'s of an inductive circuit, such as of a coil, then the impressed e.m.f., or that which would be measured by a voltmeter at the terminals of that circuit, may be determined by simple algebraic addition, as in the case of direct e.m.f.'s.

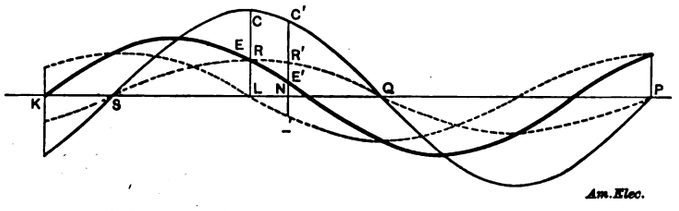



FIG. 1.—DETERMINATION OF IMPRESSED E.M.F.

As we pointed out, however, it would be impracticable to use this method where alternating-current calculations are actually to be made, and therefore an artifice is used, based upon the fact that commercial alternating currents follow a sine curve law of variation.

Fig. 1 is the illustration used in the preceding number, in which C is the current curve, from which is derived by means of the formula, $E = C R$, the resistance curve R; and also the inductive curve from the formula,

$$E = \frac{2 \pi N L C}{1000}$$

The resultant of these, or the curve in heavy line, E, was determined by adding together algebraically at each point, the sum of the inductive and resistance e.m.f.'s.

In the same article it was shown how a sine curve may be constructed. Referring now to Fig. 2, the right hand part is a duplicate of Fig. 1, and the left hand part is a construction showing how the curves given may be laid down independently of any physical considerations; that is, relying alone upon the geometrical properties of the sine curve.

For example, the current curve C may be plotted from different angular positions of the radius O C, as explained in the preceding articles. Since the resistance e.m.f. must be in phase with the current, for the reason that it increases and decreases as the current increases and decreases, O R will represent the radius from which the resistance curve R will be obtained in the sine curve construction. As the inductance curve has its zero value when the current curve has its maximum value, the relative position of the radius of that curve will be 90 degs. away from the current radius, or at O L. If now, we follow the construction given in the preceding lesson, it will be found that by revolving simultaneously the lines O C, O R and O N, the curves C, R and L will be obtained.

As the curve E of impressed e.m.f. is, at any point, the algebraic sum of the resistance e.m.f. and the inductive e.m.f., and since when the former is a maximum the latter is zero, E L in the left of the diagram will represent the impressed e.m.f. when the current has its maximum value; and drawing O E will give us the length of the radius for the sine curve construction of the curve of impressed e.m.f. Another way of looking at the matter is that since O R and O L are two forces, their resultant is the diagonal O E of the parallelogram O R E L.

The dotted lines in the circles are the positions when the heavy lines have been revolved through 90 degs.; then, it will be seen, the resistance e.m.f. and current become zero as at N, since R is now lieing on the horizontal base line. E will have moved to e and L will have moved to l, the corresponding points on the right hand diagram being e and l.

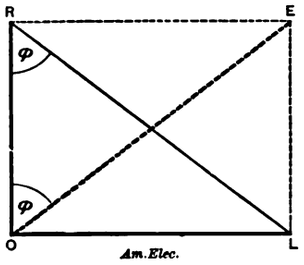



FIG. 3.—TRIANGLE OF E.M.F'S.

While this method of determining the values is less cumbersome than that involved in actually laying down the curves, it is nevertheless a process too complicated for practical use, and we will, therefore, proceed a step further in simplification, though in doing so we get further away from the physical aspect of the phenomena.

We have seen in Fig. 2 that O E, representing the impressed e.m.f., is the diagonal of a rectangle, of which the resistance e.m.f. O R, and the inductive e.m.f. O L are two sides. Suppose now that in Fig. 3, we lay down O R, the resistance e.m.f. to scale, and also O L, the inductive e.m.f. to scale, and complete the rectangle. Then O E will be the impressed e.m.f. But since the figure is a rectangle, the length of O E will be the same as the length of R L.

Therefore the problem resolves itself into laying down a right-angled triangle, one side of which—for example, the perpendicular—represents the value of the resistance e.m.f. in the circuit; and another side—the base, for example—represents the value of the inductive e.m.f. in the circuit; when the hypothenuse, R N, will represent the maximum value of the impressed e.m.f.

A very large class of calculations in alternating currents can be made with respect to such a right-angled triangle, and by a further extension, which will be treated later on, and introducing the general solution of a triangle of which three parts are known, practically all calculations in alternating currents may be very simply made.

As an example, suppose we wish to know the inductance of a given coil. First, pass through the coil a known direct-current and by means of a voltmeter determine the e.m.f. between the terminals of the coil when the current is flowing; this will give the drop in the coil for the given current, and dividing by the current will give the resistance drop in the coil for 1 ampere. Next, send through the coil an alternating current of known value and frequency, and by means of a voltmeter determine the resulting e.m.f. between the terminals of the coil; this will give the e.m.f. for the given current, and dividing by that current will give the impressed e.m.f. for 1 ampere. The latter quantity will correspond to the hypothenuse of the right-angled triangle and the former quantity to the perpendicular. It is then merely necessary to solve the triangle; that is, the square of the base is equal to the difference between the square of the hypothenuse and the square of the perpendicular; extracting the square root of this difference will give the desired inductive e.m.f. It may be added, that the resistance can be measured directly instead of by the drop method; and since we have assumed 1 ampere, the value of the resistance will be the length of the perpendicular.

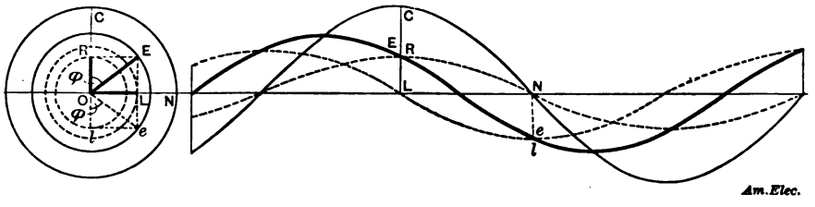



FIG. 2.—GEOMETRICAL DETERMINATION OF INDUCTANCE CURVE.

Suppose that we know the inductance in millihenrys of a coil, and also its resistance, and wish further to know how much e.m.f. must be applied to the terminals of that coil to send through it a given current. First, start out with the assumption that the current is 1 ampere. Then the resistance drop will be $I \times R$, which gives the length

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of the perpendicular of the triangle. The inductive e.m.f. will be

$$\frac{2\pi N L.}{1000}$$

and the value of this will be the base of the triangle. As the impressed e.m.f. is represented by the hypothenuse of the triangle, its square will be the sum of the squares of the other two sides. Suppose this gives, say, 10 volts for the impressed e.m.f. which corresponds to 1 ampere; if we desire 10 amperes to flow through the coil, then the impressed e.m.f. for this current will be 10 x 10, or 100 volts.

In the preceding article, the maximum values of current and e.m.f. were partly used, and in this no qualification has been made. When we actually construct the sine curves, the radii of the several circles represent the maximum values of the current, or e.m.f. All commercial instruments indicate, not the maximum, but the mean square current or e.m.f., which is the value representing the energy value. In using the triangle, however, the relation established holds for both maximum and mean square values, and in practice the latter are the only ones that will ever have to be considered. Should it be desired to lay down the sine curve geometrically, the maximum may be determined by multiplying the mean square values by the square root of 2, or 1.41. In the preceding article, the value of this square root was erroneously given as 1.7.

## Letters to the Editor

### A New Type of Generator.

*To the Editor of American Electrician:*

Sir—It is with surprise that I notice that as yet no one has publicly criticised the remarkable claim for a so-called new type of generator, a description of which appeared in the American Electrician (page 101) and in other electrical journals of recent issue.

We all remember Pennock and his "Voltage Distributor," by which he proposed to get 1000 from 1 h.p., and many other things incidentally. The principle embodied in his apparatus and in that referred to appear to be identical.

In the report of the test accompanying the description of the machine, the most glaring discrepancy is in the number of watts produced. Two 55-watt lamps were tested, one on an ordinary machine and the other on this "New Invention." The lamp on the latter appears, however, to have been the only one submitted to photometric test.

Presuming that the same style of lamp was used, 15.56 16-c.p. lamps (which it is claimed were operated by each h.p.) would, at 55 watts each, give 855.8 watts per h.p., which would be a performance so novel as to be suggestive of either Keely or Pennock.

Now, a watt is a watt, and represents a definite amount of power, and when a concern offers to furnish a machine that will maintain more lights per h.p. than the most efficient generator yet constructed, based on the supposition that the heat-retaining qualities of a filament will enable them to accomplish it, I should say look out for "sparks."

LOUIS D. BLISS.

Washington, D. C.

[The description was printed in that department of the American Electrician in which the claims of the manufacturers of the apparatus described form part of the article. Owing to the wide range of apparatus covered, and the limited data usually at hand, it would be impracticable—often impossible—for the editor to express an opinion as to the merits in each case. Besides, it is not only fair to the manufacturer, but desirable for obvious reasons, that the reader should know upon what grounds the maker believes a new piece of apparatus merits consideration; and in the department referred to, the source of the claims made is either specifically stated or clearly shown by the context. As to the machine criticised, we agree with our correspondent that the claims made for remarkable efficiency rest upon a false basis. On the other hand, the manufacturers of the machine are an old and reputable firm, and evidently thoroughly believe that the claims are well founded. The apparent violation of the fundamental law of conservation of energy has probably crept in through errors in the engine tests. The friction load was excessive due to the fact that the engine, when tested, was running also a line of shafting. The power given to the lamps is thus determined as the difference between two quantities, the determination of both of which was subject to all the inaccuracies of commercial indicator work.—Ed.]

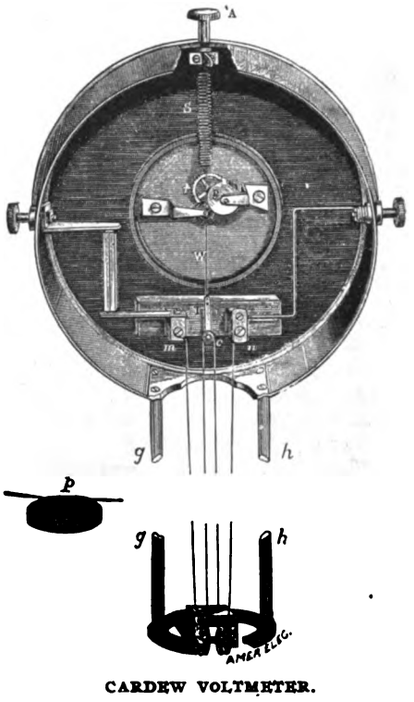
## Electrical Catechism

*284. In what way may the heating effect of the current be used for measuring?*

The energy absorbed by the resistance of the wire raises the temperature of the conductor above that of the surrounding objects. The rate at which heat is interchanged between objects varies directly as the difference of temperature between them; therefore heat is given off to surrounding objects more and more rapidly as the temperature of the wire increases. A point will be reached where the heat is given off as fast as it is developed in the conductor, and then the temperature becomes constant. At this point the conductor and the surrounding objects have expanded a definite ratio larger than their original size. The expansion of either the conductor or the surrounding objects may be used to indicate the temperature and therefore, indirectly, the current which caused it.

*285. How is the expansion of the conductor used to measure current?*

This has been found suitable only for measuring small currents. As the conductor expands, its increasing length may move a pointer through some form of lever or other multiplying device. The most common instrument based on this principle is the Cardew voltmeter, which was formerly used quite extensively, as it is suitable for either direct or alternating current. This instrument contains a fine wire about 4 yds. long and having so high resistance that it will take only a small current when connected across a circuit of 20 to 120 volts. The current through it is proportional to the pressure at its terminals, so that the motion of its pointer may be taken to measure volts. As current passes through the fine wire it becomes hot and lengthens, thus turning a multiplying gear, to which the pointer is attached. The instrument requires considerable current (0.28 amps. at 100 volts) and is not so much used as formerly.




CARDEW VOLTMETER.

*286. How is the expansion of objects near a conductor used for measuring the current?*

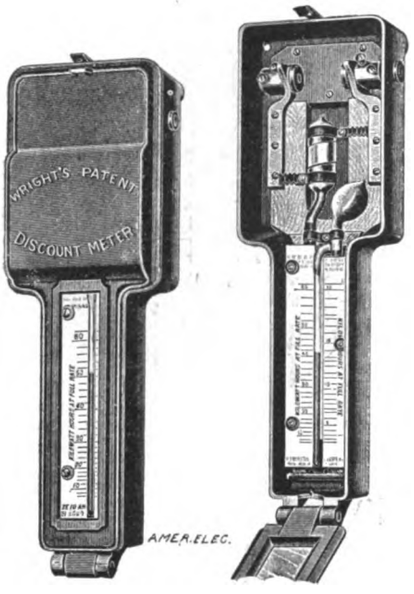
Several plans have been proposed, although only one seems to be a commercial success. One plan proposed by Forbes is to arrange a conductor as a coil below a small windmill, which will be rotated by the air put in circulation by the heating of the conductor. The speed of the windmill or the number of turns it makes in a given time registers the amount of the current. Others have tried placing the conductor around a thermometer, whose rise of temperature would thus measure indirectly the

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current in the conductor. One form of this is coming into extensive use for determining the largest current used at any time by a consumer, known as the Wright maximum demand meter.

*287. Explain the Wright demand meter.*

It consists of a glass tube with two bulbs, around one of which the conductor is wrapped, the tube being partly filled with a liquid, as shown in the accompanying illustrations. The passage of current heats the air in the left bulb and the expansion of the air inside forces more or less of the liquid into the bulb at the right, and into the graduated overflow tube, from which it cannot be removed except by tipping up




A WRIGHT DEMAND METER.

the meter. The amount of liquid that flows over depends upon the amount of expansion of the air, which depends upon the strength of the current. Any larger current will send more liquid into the overflow or indicating tube, but a smaller current will not. The instrument thus indicates the largest amount of current used at any time, which gives the station manager a basis for estimating the discount to be allowed from the bill as calculated from the regular meter.

*288. Is any other heating effect used for measuring the current?*

The fact that the resistance of a conductor changes with the temperature has been used for purposes of measurement, notably in the Howell lamp indicator or voltmeter, formerly made by the Edison Company.

*289. Upon what principle is the Howell lamp indicator made?*

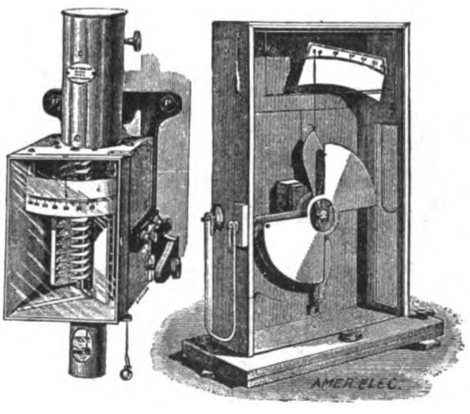
It depends upon the fact that the resistance of most metals increases with rise of temperature, while that of carbon decreases. Two circuits are arranged so that when equal or proportional currents flow in each, one neutralizes the effect of the other upon a galvanometer or other current indicator. One circuit contains a carbon resistance consisting of a special incandescent lamp; the other contains a long fine wire of iron or some other such metal whose resistance increases rapidly as its temperature increases. These two circuits are coupled in multiple and are connected across the circuit, whose voltage is to be kept constant. If the pressure increases, more current flows through each circuit and thus raises the temperature of each; this increases the resistance of one and decreases that of the other, so that the two currents are no longer equal or proportional as before, so that one affects the galvanometer and deflects the pointer in one direction. If the voltage becomes lower than the standard for which the instrument was set, the resistances change in the opposite direction and the pointer is moved accordingly. This instrument does not measure the voltage, but simply shows whether it is above or below the standard. It is not made now.

*290. How is the electro-static effect used for electrical measurement?*

A number of instruments are based upon the fact that two conductors attract one another when any difference of potential or electric pressure exists between them. If one is delicately suspended so as to be free to move, it will approach the other. This is developed in the electro-static voltmeters of Lord Kelvin (Sir William Thomson) and others, also in the electro-static ground detectors of the Stanley and the General Electric companies.

*291. Describe and explain the Kelvin electro-static voltmeter.*

This is made in a number of forms, one of the simplest being shown in the figure. It consists of a metal case containing a pair of highly insulated plates, between which a delicately mounted paddle-shaped needle is free to move. When the needle is con-

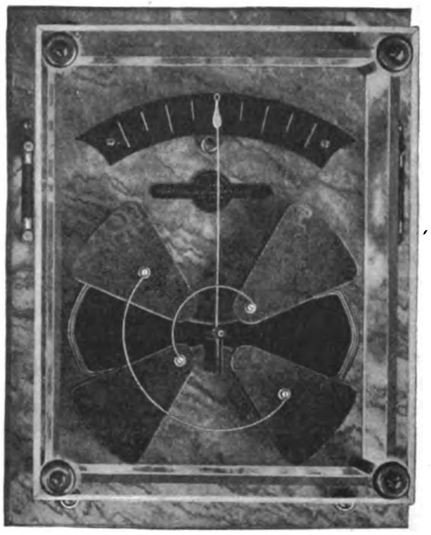



THE KELVIN ELECTRO-STATIC VOLTMETER.

nected to one side of a circuit, to the other side of which the stationary plates are connected, the needle is attracted and moves between them a certain distance indicated by the pointer. Adjusting screws at the lower end of the needle allow it to be balanced so that its center of gravity is the least bit below the center of suspension. The motion of the needle is then opposed by gravity. Different weights may be hung upon the needle to change the range of the instrument. The form having only two stationary blades, and one movable blade is suitable for measuring from 200 to 20,000 volts. By increasing the number of blades, the sensitiveness may be increased so that it will measure as low as 30 volts. The sensitive laboratory form known as the quadrant electrometer will measure a small part of 1 volt.

*292. Describe and explain the electro-static ground detector.*

One simple form is shown in the figure. It is a sort of differential static voltmeter having one movable vane and two stationary pairs of vanes. The movable vane is electrically connected with the ground, one



AN ELECTRO-STATIC GROUND DETECTOR.

pair is connected to the side of the circuit to be tested and the second pair to the other side. When both sides of the circuit are highly insulated so as to be free from "grounds," the needle is attracted equally by both pairs of vanes and so remains in the neutral position. Now, suppose that the insulation of one side becomes impaired so that it is more or less grounded; the pair of vanes connected with that side now attracts the needle less strongly than before, because the difference of pressure between them is less than before; the attraction between the needle and the other pair of vanes is not less but rather more than before, because the opposite wire has approached more nearly the potential of the ground and of the grounded needle. The needle therefore moves away from the pair of vanes connected with the wire that is grounded. The instrument shown is that of the Stanley Company, that of the General Electric Company being in principle the same. For use on circuits of more than 10,000 volts, the stationary vanes are not connected directly with the wires, but are charged inductively by auxiliary vanes which are insulated from the instrument and are connected with the circuit.

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# Queries and Answers

**What kind of a storage battery is best for experimental work?** R. E. B.

Any kind.

**How much iron wire and what size is needed to reduce a voltage from 110 to 10, and give a current of ½ ampere?** G. E. N.

Use a 110-volt lamp.

**At what temperature does a storage battery solution freeze?** G. L.

Diluted sulphuric acid freezes at about 0 degs. F.

**Is an ampere-hour meter as accurate on a 110-volt secondary circuit of 16,000 alternations as a wattmeter would be?** W. S. S.

Yes, except in the case of varying potential or lagging currents.

**Will high and low voltage have equal effect on a magnet if the amperes remain the same?** F. W.

But the amperes will not remain the same.

**If a voltmeter registers an alternating current voltage of 1000, what is the maximum voltage?** C. A. K.

The maximum voltage will be 1410 when the mean square voltage is 1000.

**What h.p. is required to run a 2000-c.p. arc lamp?** C. J. M.

For street lighting it is usual to estimate 1 h.p. per full arc. At 45 volts and 10 amperes, 3-5 of a h.p. is used in the arc.

**Why is the positive pole of a dynamo connected with the trolley in street car working?** J. J. F.

To reduce electrolysis on neighboring pipes, or to confine its action to the district nearest the station.

**What size of aluminum wire is equivalent to 3-0 copper wire?** H. L. C.

The aluminum wire will have a larger section in the ratio of 100 to 63. Its weight, however, would be less in the ratio of about 1 to 2.

**What loss is there in a transformer on an open circuit?** C. J. M.

The iron loss, principally due to hysteresis; that is, the energy required to magnetize and demagnetize the core. There is also an eddy current loss and a negligible copper loss.

**Would it not be beneficial to use smaller than No. 36 wire on the secondary of an induction coil?** F. E. G.

As the inductance drop in the secondary due to the number of turns enormously exceeds the resistance drop, nothing would be gained practically by decreasing the latter.

**How is a Ries regulating socket wound?** H. S. K.

With sixty turns of stranded wire on a soft iron ring, connections being made to a desirable number of regulating points. This will give a maximum reduction in the light of 70 per cent.

**What is the equivalent on the meter system of a charge of 35 cents per month for a 16-c.p. incandescent lamp used on an average of four hours per day?** D. H. D.

At New York City meter rates, the cost would be $1.20. Thirty-five cents per month is undoubtedly far below cost of generation and delivery.

**I wish to construct an electromagnet for use in a grinding machine that will hold pieces of iron as large as a ⅝-in. bolt at a distance of 8 ins. What should be the winding?** A. R. M.

What you desire to do is practically impossible. It will be best to cause all the material to pass over magnet poles, so that any iron present will come into contact and be held by the same.

**How can I transform an alternating current of 52 volts down to 3 or 4?** S. A.

Wind wire on a soft iron core and connect between the turns, the ratio of the turns between connections being to the entire number of turns as the desired voltage is to 52. The simplest method would be to make connections to the turns of the secondary of an old transformer.

**How much wire will I need to boil coffee in about 30 minutes on a 550-volt railway circuit with three or four 110-volt lamps as resistance?** F. B.

To raise one quart of water from 60 to 212 degs. in 30 minutes will require about 1-5 h.p., or the heat equivalent of about three incandescent lamps. Therefore, the resistance of the heating wire should be three times the resistance of an incandescent lamp in such a circuit as that indicated.

**How many k.w.-hours will a 25-h.p. motor consume in one hour loaded to full capacity, and what amount of coal will it take to furnish this power?** A. W. A.

With a motor of 80 per cent efficiency, the input will be about 30 h.p., which is equivalent to about 22.5 k.w. A k.w.-hour may take on the average anywhere from 3 to 20 lbs. of coal. The fuel, however, is but a small part of the cost of electrical energy delivered.

**One of several 600-amp. machines runs with cool fields and armature, but the commutator becomes hot with both copper and carbon brushes, and sparks badly with the former. The other machines run cool. What is the probable trouble?** C. T.

The brushes may not be set on the proper line of communication, or they may not be ground down to a good fit. If the other machines run well the trouble is probably in the brushes themselves or their position.

**What should be the winding of the 1-h.p. bipolar motor described in the December number, for electroplating?** P. M. R.

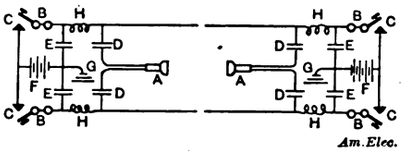
Armature coils of No. 8 wire, two in parallel, each coil having two turns of the double wire. Each slot will contain eight wires, two wide and four deep. Field coils of No. 12 wire 2¼ ins. deep and as long as can be gotten between poles in putting coils on cores. The commutator should be long enough to give ¾ sq. in. brush contact without lapping more than two segments.

**How may a choking coil be used on a 2000-volt series line to obtain a voltage of 200 between its terminals?** E. W. C.

Experiment with a small transformer by cutting out primary turns and testing with the station secondary voltage. The voltage between the terminals with the line current flowing will be to the secondary voltage used, as the series to the latter current. Not having a low-reading ammeter, the current for a few turns may be determined, and the number of turns necessary for 200 volts very simply calculated by means of a proportion.

**How can telephone and telegraph currents be sent simultaneously over the same wires?** D. I. T.

Referring to the accompanying sketch, B, B, are telegraphic instruments; C, C, telegraph keys, and A, A, telephones, there being two grounded telegraph lines and one metallic telephone line to a two-wire circuit. H, H are choke coils, which prevent the high frequency telephone currents

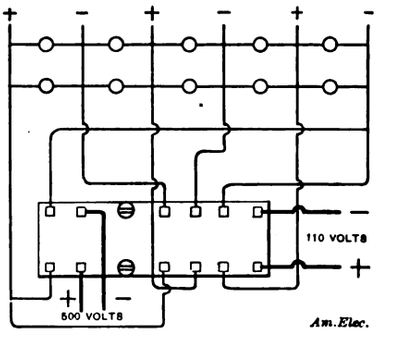


Am. Elec.

from passing out of the telephone circuit, and D, D are condensers, which prevent the telegraph current from the batteries F, F from affecting the telephones. E, E are condensers across the telegraph instruments, in order to round off the telegraphic current so that it will not affect the telephone diaphragms, the choke coils, H, H, having also a similar effect. Telephone lines may thus be used for telegraphy without the knowledge of the telephone user.

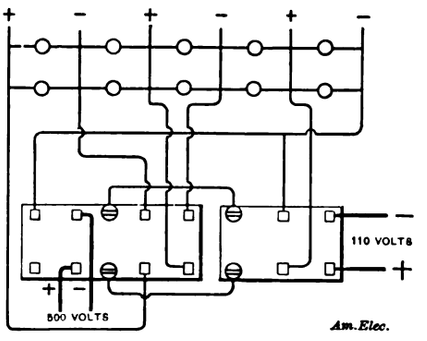
**How can lamps be wired so that they may be supplied from either 110 volt or 500 volt circuits?** E. M. H.

The accompanying diagrams show two



Am. Elec.

ways. The first involves the use of one special double-throw switch with long blades which will enter four clips in the



Am. Elec.

right-hand position. The second uses one double-pole double-throw switch such may be found on the market.

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## ALUMINUM, ITS HISTORY, MANUFACTURE AND USE.

The name aluminum is derived from *alum* a Latin word, which applies to all bodies having an astringent taste. Its basis is that of an argillaceous earth, and with the exception of oxygen and silicon, with which it is usually combined, it is the most widely distributed element in nature, forming, it is claimed, about one-twelfth of the earth's crust. It is a tin-white metal, but gray when powdered. It is odorless and tasteless, and is about as hard as silver after fusion, but when hammered about as hard as soft iron. It is malleable, ductile, very sonorous, and may be highly polished, but is only slightly magnetic. The melting point of aluminum is about 1200 deg. F. Its specific gravity as a casting is 2.56, being the lightest of the commercial metals, and bulk for bulk is only one-third as heavy as iron.

The electrical conductivity of pure aluminum wire having the same cross section as silver wire is about 63, as compared with silver at 100, and compared with copper, it is as 60 to 100, but the weight for weight aluminum wire will have a conductivity of 200, copper being taken at 100.

Aluminum unites readily with nearly all the common metals, and forms many useful alloys, in some of which its tensile strength is greatly increased. It is difficult to solder aluminum, however, due to its high heat conductivity, as it causes molten solder to harden before flowing sufficiently. The wires and bars are easily spliced by inserting the ends in a thin tube of the same material, then twisting the section.

As an ore aluminum usually occurs as irregular, pebble-like concretions. A few foreign deposits are more or less stratified. The minerals from which aluminum is principally prepared are known as bauxite, cryolite, native sulphate of aluminum, alum salts, and from the clays. The value of the clays, however, especially those like kaolin, which carry a large amount of aluminum, is small in comparison with bauxite, which is double and triple hydrated oxide, and has only a small amount of iron and silica to be removed in preparation for the reducing operations.

The principal deposit of bauxite, which is the ore most extensively used, so far found in this country are in several counties in the northwest of Georgia, and in the northeast of Alabama, where the supply seems to be very large.

The ore is found in a belt 30 miles wide and 75 miles long, not found in continuous beds or in veins, but in pockets having well defined outlines ,and containing compact masses of ore. Useful varieties of the ore are also found in Arkansas, Colorado, New Mexico and Greenland, and in southern France, Asia Minor and South America.

The Pittsburgh Reduction Company, which is the principal producer of aluminum in this country, and, in fact, has only one competitor in the old country, controls the Alabama and Georgia deposits, and here mines its principal supplies. One branch of the works of this company is located at New Kensington, 18 miles from Pittsburgh, and the other at Niagara Falls, where electric energy is employed in the process of reduction. The ores are first delivered to the Pennsylvania Salt Manufacturing Company, whose works are in the neighborhood of the Kensington plant of the Pittsburgh Reduction Company. Here the ore undergoes a certain chemical process of purification from the natural impurities of silica and oxide of iron. It is then delivered to the Kensington plant of the reduction company in bags, in the form of a perfectly white, fine powder. The first proces sis to remove the water of hydration, of which the ores contain about 30 per cent, and this is done by heating the material in peculiarly designed furnaces in which natural gas is employed as fuel.

When properly prepared, it is shipped to the Niagara Falls plant, where the pure metal is extracted and molded into pigs, when it is shipped back to the Kensington plant, where it is cast into billets, or smaller pigs, or any desirable form. The casting is done in crucibles in furnaces of the type usually employed in brass foundries. The billets are next rolled into plates, bars or rods, and afterward the rods are drawn into wire of various sizes.

The electrical separation of aluminum at the Niagara Falls works is done by what is known as the Hall process, consisting in the electroylsis of aluminum dissolved in a molten bath of the fluoride of aluminum, and the fluoride of one or more metals which are more electrically positive than aluminum, which quality is generally found in sodium or potassium and calcium.

The process is carried on in iron pots placed in series. The pots, as well as the reduced metal lying in them, serve to form the negative electrodes, or cathodes, while the anodes are of carbon usually, and dip into each kettle of the metal. The negative connections are made by having copper bars riveted to the iron pots, and which are in circuit with the positive poles of the next pot, the current going thus in series from one pot to the other, and back to the negative side of the dynamo.

A large continuous current having a low voltage is passed through the mass, melting it, when the deposition of aluminum in a molten condition is brought about.

The bath is maintained in a constant condition by frequent fresh supplies of alumina. The molten aluminum that collects at the bottom of the pots is dipped or siphoned out as water would be removed from under a layer of oil, due precaution being taken to prevent the molten electrolyte from being taken up with the metal, and this is done without interrupting the current passing through the bath. It is estimated that the amount of energy required to reduce one pound of aluminum from its oxide is about 5 h.p. hours.

The Pittsburgh Reduction Company has recently increased the capacity of the Niagara Falls plant by 75 per cent, and now the works have a capacity for producing nearly a million pounds per month. The company has also added fourteen trains of rolls, including continuous rolls, and several complete wire-drawing benches to the equipment of the new Kensington plant; for operating the same, a number of new engines aggregating about 1700 h.p. have been installed. The original buildings have been extended, and two neighboring glass plants purchased, which have been converted into suitable shape for the aluminum processes. The new Kensington plant covers a tract of 17 acres in extent on the bank of the Allegheny River, which is navigable to Kensington.

The enlargement of the works has been undertaken to meet the increased demand for aluminum conductors for the electric transmission of power, and for use in the manufacture of dynamos and motors, as well as for an increased demand for use in the mechanical arts.

The company has been making extensive tests during the winter on long sections of wire of different metals, which are mounted side by side near the works. Daily records of the temperature, and the records of sag as well as relative expansion and contraction of the different wires have been made, so that the relative merit of aluminum wire for withstanding the climatic changes has been fully established. A corps of chemists and electricians are constantly employed by the company for testing and determining facts with reference to the economical production of the metal, and for determining its value for different industrial purposes. The processes are now so thorough that the company is prepared to furnish the metal in ingots guaranteed to be over 99.75 per cent pure. It also furnishes several other grades, as well as a number of alloys and sheets are furnished in varying grades of stiffness from soft to hard.

## PUMPING HOT WATER.

It is to be inferred from the fact that feedwater heaters of the "open" type are coming into more general use, that the hot water delivered by them (which will have a temperature very close to 212 deg. F., or even higher, if there is any back pressure on the heater) can be handled (that is, pumped), without much difficulty. This is the case, for it is only a question of a proper location and equipment in order to satisfactorily perform this work.

The real secret of pumping hot water is in keeping at all times a solid body of water against the water piston, so that no opportunity will be given for the water to flash into steam. If the atmospheric pressure be reduced on water near 212 deg. F. by the partial vacuum of the suction of a pump owing to small piping or other causes the water will vaporize as the boiling point or the pressure goes down. Hot water cannot be lifted by a pump, because the instant the pressure is reduced by the water piston moving away from the inlet end of the pump, steam is formed, and this cushions the pump, prevents it from doing work, and causes it to race. It is only necessary to deliver the water to the pump in a solid mass, having some head; if the piping is short and free, a head of one foot will an-

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swer in some cases, though a greater head is better. With a high head, water can be pumped at a temperature considerably above 212 deg. F.

In arranging to take the supply from an open heater, the pump should be set close to the heater, and if the pump is raised up to bring it to a convenient height for the engineer to examine or regulate packing, etc., then the heater should be raised the same height. The piping should be kept free and of large size right from the heater up to the pump, where it can be bushed down if necessary.

This eliminates, to a large extent, the friction from long lengths of pipe, and from short bends, which can also be offset in many cases by erecting a loosely capped stand pipe in the pump suction, close to the pump, which gives a reservoir of water at the same height as that carried in the heater, directly at the pump.

It should not be forgotten that the pump suction valves and their springs must be lifted by the head of water before the water can enter the pump. In many cases where trouble is experienced in pumping hot water, the cure is to be found in lightening these suction valve springs, which are too strong; that is, they offer too much resistance for the available head or pressure of the water.

Brass fitted pumps, having metal valves, are to be preferred, as rubber or composition valves are affected at the temperature of water near the boiling point. Probably the best pump for handling hot water is an outside packed piston pump.

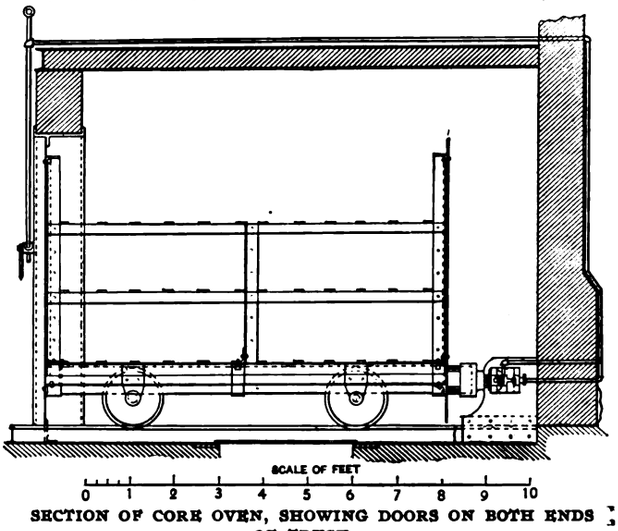
With a little attention to the details as suggested above there need be no more trouble in pumping water even at 230 deg. to 240 deg. than in handling it at 150 deg.

## THE GENERAL ELECTRIC COMPANY'S NEW IRON FOUNDRY.

The latest extensive addition to the manufacturing facilities at Schenectady of the General Electric Company is a large foundry which was first put into operation on January 5, 1899. The building, which stands to the east of the other works of the company, was carefully designed after a study of other similar plants, and contains some novelties in foundry construction.

The main structure is over 500 ft. in length and 140 ft. wide, and down its center runs the main bay, 65 ft. wide. At one end is an L, about 100 by 12 ft. in size, where all the castings are cleaned. The estimated capacity of the foundry is about 100 tons per 24 hours, 80 tons having already been poured in one day with 325 men working.

The crane equipment is unusually elaborate. Two 40-ton Morgan cranes with main and auxiliary hoists span the main bay. One 10-ton Morgan crane serves the cleaning room and 4 smaller two-motor Box cranes span one of the galleries where considerable heavy work is done. These latter cranes are conveniently controlled by chains reaching down to the floor from the switches and controllers above. Besides these, three 5-ton jib cranes will be installed later to relieve the 40-ton cranes of considerable local work. These jib cranes will be portable and can be lifted and placed in any position in the main bay by the bridge cranes overhead.



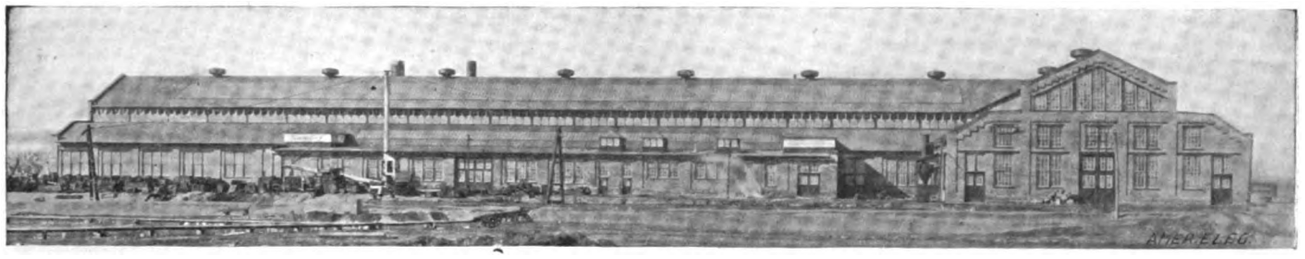

SECTION OF CORE OVEN, SHOWING DOORS ON BOTH ENDS OF TRUCK.

One of the most striking features of the foundry is its cleanness, the perfection of its lighting and the purity of its atmosphere, three qualities generally conspicuous for their absence in iron foundries. The interior walls are painted white, the roof of the main bay is almost entirely one vast skylight of woven-wire glass, and a large number of arc lights are in place for night work. Two large ventilating and heating blowers are in use, and the windows in the monitor of the main bay may be opened or shut in groups of eighty by chains brought down to the floor. By properly manipulating the windows according to the direction of the wind, and setting the dampers in the blower ducts, the structure may be cleaned of dust, smoke and steam even when metal is being poured or castings shaken out.

There are at present two Paxson Colliau cupolas in service, one of 17 and the other of 7 tons capacity per hour. A third cupola of 11 tons will be brought over from the old foundry. Around the cupolas is grouped all the small work to which metal is carried by hand, the heavy work supplied by ladles carried by the cranes being at a greater distance. One of the most interesting features of the foundry is the arrangement of the core ovens. There are six of these, two having very large doors about 10 by 12½ ft. in size. The hinges of these doors are mounted on ball bearings so that, in spite of their great weight, the doors can be moved by the pressure of the little finger. The four smaller core ovens are ingeniously fitted for continuous heat. Each is equipped with a truck or car, pushed out from or pulled into the oven by compressed air, and on each end of the truck is a door so that whether the truck is in or out the oven is always closed and under heat. The general arrangement is shown in the accompanying figure. The longer gentle heat that can be given in an oven so constructed apparently gives stronger cores.

The cranes, blowers and all other power absorbing apparatus in the foundry are, of course, motor driven, there being some twenty-seven motors scattered through the structure. The wires and steam piping are brought in through a conduit crossing the two main crane spans, this conduit being fitted with cast covers grooved to give tracks for both the 36-in. gage cars running around the works in general and the 21½-in. cars which run only inside the foundry.

The foreman's office is at the middle and to one side of the main bay, so as to give a view over the whole operating floor. Elaborate lavatories, shower baths and private lockers for the men have been provided. The old foundry which this modern structure has replaced will be turned into a machine shop, in addition to which the General Electric Co. is building a very large new machine shop.



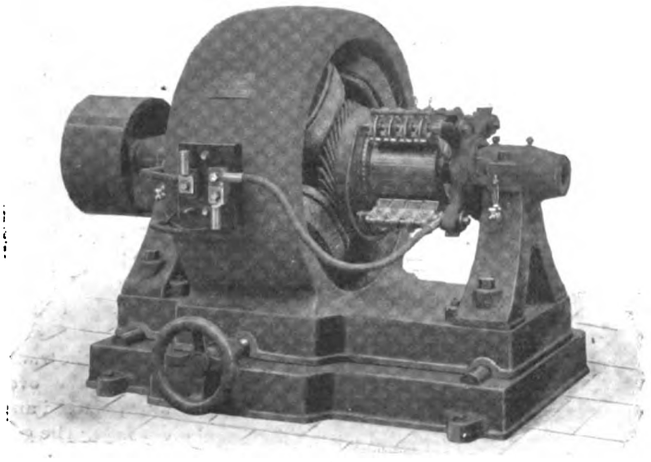
A VIEW OF THE FOUNDRY, SHOWING AREA OF SKYLIGHTS AND EXTENT OF MONITOR WINDOWS; VENTILATING FAN INTAKES IN CENTRAL FOREGROUND CLEANING ELL AT EXTREME RIGHT AND CUPOLA STACKS IN LEFT BACKGROUND.

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# New Apparatus and Appliances.

### THE JANTZ & LEIST GENERATOR.

The engraving below illustrates the line of generators built by the Jantz & Leist Electric Co., of Cincinnati, O. As the illustration shows, the machine embodies the principles and proportions of modern design. It is of the four pole spherical type, with laminated soft wrought iron pole pieces, cast in. The field coils are, as usual, machine wound and shunt and series coils are separately insulated. Carbon brushes are used firmly held in position by heavy bronze holders fitted with adjustable automatic tension feed. The bearings are of phosphor bronze, self-oiling and self-aligning, and the sub-base is cast with sliding rails and belt tightening attachments. The machines are made in sizes from 3 k.w. to 65 k.w. and of the standard voltages, 110, 220 and 500 volts.



A 4-POLE BELT-DRIVEN GENERATOR.

### AN INSULATED ARC LAMP HANGER.

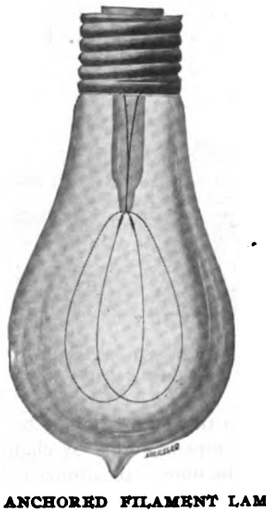
The combination of a bell-shaped insulating hanger, similar to those used on over-head trolley lines, with a wooden break-arm makes a remarkably neat and simple insulating support for arc lamps. The accompanying figure illustrates such a hanger made by the Ohio Brass Co., of Mansfield, Ohio. The two metal parts of the hanger are made of malleable iron, insulated from each other by the well known Dirigo insulation which is widely used in the trolley wire appliances made by the same company. The iron parts are so shaped that even should the insulation become shattered, the lamp could not fall unless the castings also were broken. The hook to which the lamp is attached is made deep and narrow to prevent accidental detachment. The break-arm is of seasoned hard wood, covered with a preservative paint and fitted with porcelain insulators. The hangers are tested at the factory with 6,000 volts alternating current and are built to support a weight of 2,000 pounds.



AN ARC LAMP HANGER AND BREAK-ARM.

### THE "NEW LYNN" LAMP.

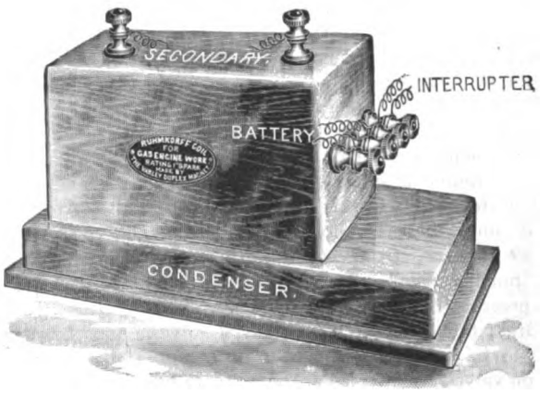
The accompanying illustration shows a new lamp put on the market by the Lynn Incandescent Lamp Company, of Lynn, Mass. The filament is oval in shape, designed to fill the bulb evenly with light and to obtain the maximum resistance against jars, vibrations or sagging. It is anchored to a glass stem direct without wires. The company has recently been granted a patent for this anchorage. The works of this company are fortunately located in an electrical center where the skilled workmen and workwomen, so necessary for the production of high-grade incandescent lamps, are easily obtainable. This is one reason for the high grade of lamps that the company can turn out at a reasonable price.



AN ANCHORED FILAMENT LAMP.

### AN INDUCTION COIL FOR GAS ENGINE IGNITERS.

Electrical ignition is for many reasons preferable to other methods in use on gas and gasoline engines. The earlier igniters consisted of contacts within the cylinder in which the gas was ignited and supplied with current through inductive coils which gave a considerable spark when the circuit was broken. A method far preferable is the use of a contact outside of the hot chamber, accessible for cleaning and not exposed to the destructive action of the burning fuel. This can be simply obtained by means of an induction coil with a make and break device operated by the engine at the proper point of the cycle and a secondary coil connected with two terminals within the cylinder. Such a coil, as shown in the accompanying illustration, is made by the Varley Duplex Manufacturing Company, of Jersey City, N. J. It is fitted complete with a condenser to increase the discharge in the well-known way.




A GAS ENGINE IGNITION COIL.

### A NOVEL REFLECTING SHADE.

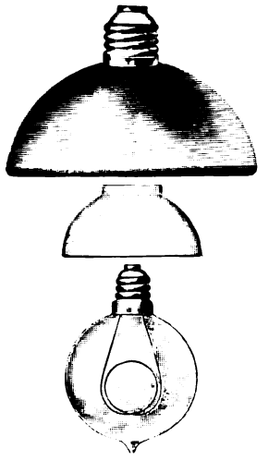
A simple and neat reflector for incandescent lamps is shown in the accompanying illustration, and is made by Schiff, Jordan & Co., of 232 and 234 Greenwich Street,



A REFLECTING SHADE WITHOUT A SHADE HOLDER.

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New York City. The device, which is known as the "S. J." reflector, consists of an outer shade of silvered glass fitted with a base that screws into the lamp socket and an inner reflector of porcelain that fits snugly over the lamp. The base of the

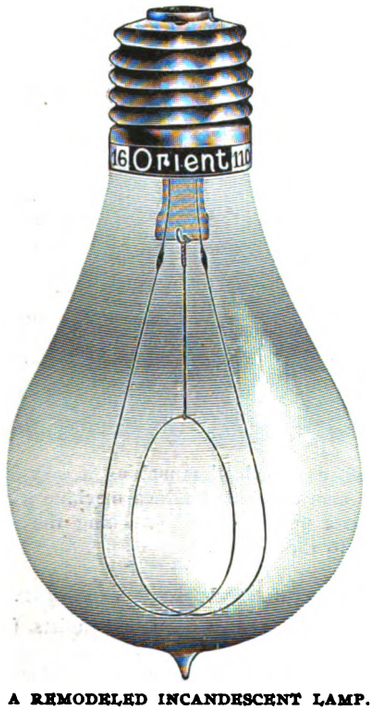


REFLECTING SHADE AND LAMP TAKEN APART.

lamp screws into a socket in the outer shade; this intermediate receptacle thus doing away with the necessity of a shade holder.

### THE REMODELED ORIENT LAMP.

Some time ago The Orient Electrical Company of Youngstown, Ohio, decided to modernize its factory equipment and processes by the adoption of the very latest machinery, devices and instruments known to the lamp business. The plant was overhauled completely, old-time appliances and




A REMODELED INCANDESCENT LAMP.

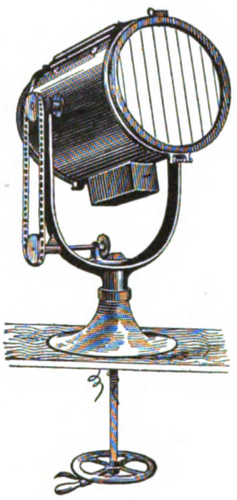
instruments were thrown out and old processes abandoned, so that to-day the company has a modern lamp factory and employs the most approved processes in the manufacture of its incandescent lamps.

The new lamp has been thoroughly tested and is claimed to be a decided success in every sense of the word. It contains the oblong loop, coiled filament, which is anchored from the mount by a process which is used exclusively by this company. That its new lamps are meeting the requirements of the most critical purchasers is attested by the fact that it is now selling to some of the largest consumers of incandescent lamps in this country, both in central stations and isolated plants. It also manufactures a special street railway lamp which is giving general satisfaction.

The company has recently opened offices in the Havemeyer Building, 26 Cortlandt St., New York City, where Mr. Francis Granger is in charge, with a complete stock of standard lamps for immediate delivery to the Eastern trade.

### AN EASILY MANIPULATED SEARCH LIGHT.

The accompanying cut illustrates one of the many types of marine projectors and



A HAND-CONTROLLED SEARCHLIGHT.

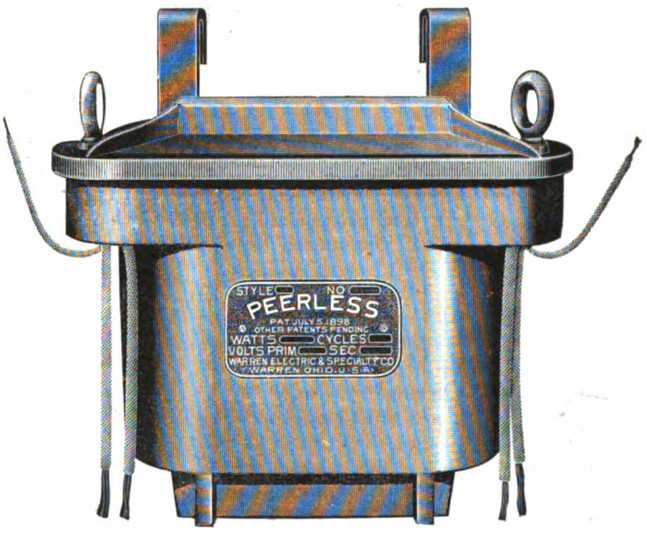
search lights manufactured by Chas. J. Bogue, 213-215 Centre street, New York.

This apparatus is designed for use on the roof of the pilot house, the light projected from it being entirely under the control of the pilot. The mechanism is simple and easy to handle and consists of a hollow tube running to the standard of the projector through the roof of the pilot house. A wheel is attached to the end of this tube, through which runs a rod extending through the contacts, and engaging with bevel gears and a sprocket carrying a chain over a second sprocket on the bearings of the cylinder. A lever handle at the end of the rod engages with a ratchet on the under side of the hand wheel; thus, by turning the wheel, the light sweeps the horizon, and by moving the lever the gears are set in motion and the light beam is given an up-and-down motion.

These projectors are made in various sizes, from an 8-in. size taking 10 amperes, giving a beam effective at one-half a mile up to a 32-in. throwing the light over six miles.

### THE PEERLESS OIL TRANSFORMER.

A line of transformers, embodying the various improvements which have been developed in transformer designs of the last few years, is illustrated in the accompanying figure. The features apparent on the exterior of this type are the over-hanging eaves under which the terminals are brought out vertically downward, and the handy method of support. Four lugs cast on the transformer case hang over two cross pieces, bolted to inverted L-shaped bars which may be conveniently hung over cross-arms, joists, &c. The four terminals of the two coils of the secondary are brought out so that the connection can be changed from parallel to series, or vice versa, on the outside of the case. The case is either japanned or painted with aluminum paint like the up-to-date U. S. mail boxes. The performance of the transformers as given by the makers is another indication of modern progress in transformer construction. The one kilowatt size is listed with a core loss of 2.2% and a regulation of




THE PEERLESS OIL TRANSFORMER.

2.5%, while in the 10 kilowatt size the core loss comes down to 0.8 of 1% and the regulation to 1.9%.

### THE TRIUMPH EXHAUST FAN.

The exhaust fan shown in the accompanying illustration is built with a flat square back, owing to which fact it can be easily and cheaply placed in position. After being simply lagged or bolted up



A BELT-DRIVEN EXHAUST FAN.

with the flat back to the opening, the fan is ready to run, no other frame work or support being required. Another great advantage of the Triumph exhaust fan is its adjustable self-oiling boxes which are pro-

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vided with phosphor bronze bearings, not babbitt, cast iron or other cheap bearings, thus securing the best and most durable bearing known to the trade. As the life of a fan depends entirely on the bearings, it follows that the quality of the latter largely determines the value of the fan.

The Triumph fan has a smaller number of blades than is usual in fans of this class, but the manufacturers claim this to be a great advantage as the ingress and egress of air is effected with greater ease than when a greater number of blades is used.



A WATER BLOW FAN.

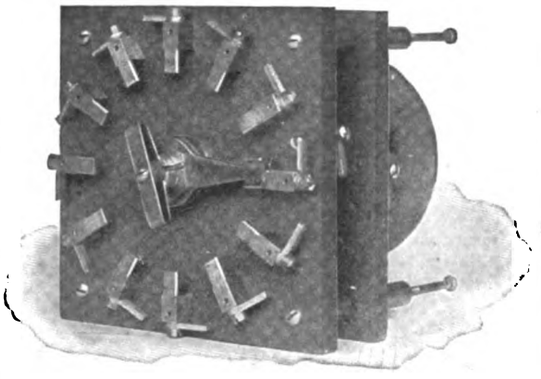
The makers are so sure of this fact that they warrant the Triumph fan with five or six blades to show a better efficiency than any other fan equipped with ten or twelve blades, or in other words to use less power.

These fans are made for belt service only, as almost all users have power at hand, but if it should be necessary to purchase a separate electric motor, the manufacturers of the Triumph fan state that a first-class electric motor and one of their fans can be bought for fifty per cent. less money than any direct connected fan and motor. The belted combination is also advantageous where extreme heat, acids, steam, etc., will pass through the fan, as in such places it is often inexpedient to use direct connected fans. The Triumph exhaust fan is made by the Specialty Manufacturing Company, Indianapolis, Ind., which is also placing on the market a water blow fan, known as the "Junior," to meet the demand for a good and serviceable fan of this type at a low price. This fan has a ground tool steel shaft and a hard brass bush or bearing, and is guaranteed by the manufacturers to be one of the most efficient and durable water fans ever offered to the trade. The motor and base are enameled in black. It has 13-in. blades of spring brass, nickel plated, and protected with a wire guard, and the motor is equipped with a jet 1-16 in. in diameter, thus insuring economical water consumption. The inlet or jet holder is provided with a thread which fits an ordinary ¼-in. hose coupling, enabling it to be easily and cheaply fitted with rubber hose for service and waste. The fan operates on any pressure from 30 lbs. upward, and weighs 9 lbs. complete.

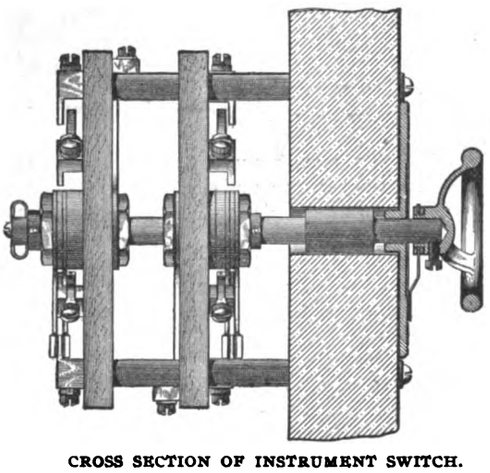
### VOLTMETER AND AMMETER SWITCHES.

The convenience of a voltmeter switch by which one instrument can be connected with any one of a large number of machines or centers of distribution is well recognized, but similar switches are comparatively rarely used with ammeters. Where the full current to be measured passes through the ammeter it is, of course, impossible to equip the instrument in this way, but with ammeters of the low resistance shunt type any number of shunts can be connected with the switch and through it to one instrument. This requires, however, switch contacts of very low resistance, as the e.m.f. across the shunt is extremely small.

Such a switch is that built by the Western Electric Company and known as "Type F," illustrations of which are shown herewith. The high conductivity is obtained by the knife contacts, which are capable of carrying 15 amperes without heating. The positive and negative poles are in two different planes on white marble slabs, both fitted behind the switchboard as the cross section



FRONT AND END VIEWS OF VOLTMETER AND AMMETER SWITCH.



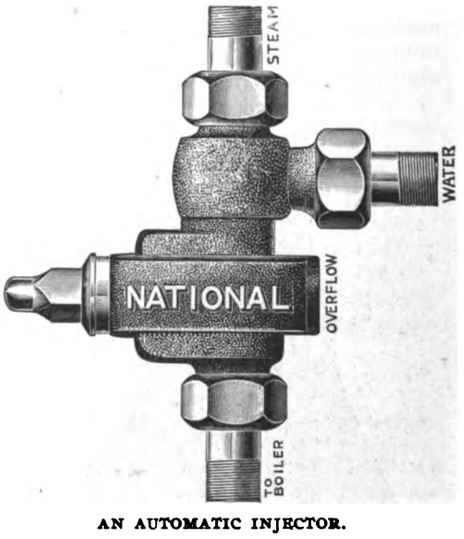
CROSS SECTION OF INSTRUMENT SWITCH.

clearly shows, the contacts being rotated by a hand wheel on the front of the board, and the position indicated by an index finger working on a graduated circle. These switches are built for any number of circuits from two up to twelve, and are readily applied to marble or slate switchboards from 1 to 2 ins. in thickness. The space occupied at the back of the board is only 6½ ins. square, projecting 6 ins. from the surface.

### THE NATIONAL AUTOMATIC INJECTOR.

An injector, the starting of which is automatic, requiring only the turning on of the steam, is illustrated in the accompanying figure and is made by the National Injector Co., of 98 Woodland Ave., Cleveland, O. The other strong features claimed for this injector are equally good starting or working when taking water with a pressure or from long lifts or lifting through hot suction pipe and working at unusually high temperatures.

The National injector has no sliding tubes and lime cannot deposit so as to interfere with the range or the perfect working of the injector or prevent the tubes from coming out. As the tubes are not screwed in, they can be put in or taken out without a wrench, thus making it easy for every man to repair his own machine with duplicate parts without returning the injector to the factory.




AN AUTOMATIC INJECTOR.

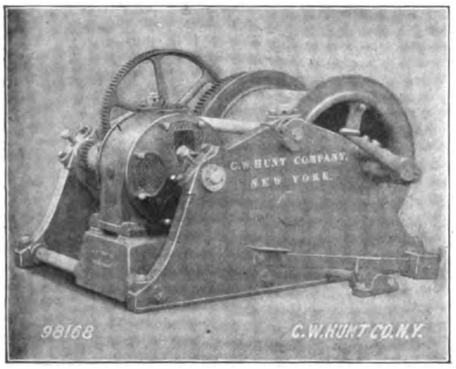
### THE HUNT ELECTRIC HOISTING ENGINE.

The disadvantages of steam hoists for many purposes are only apparent when their performance is compared with that of hoists driven by electric motors. In the large cities on the temporary work of new buildings the cumbersome, noisy and smoky steam hoist with its extremely low fuel economy gives a good opportunity for the introduction of electric hoisting en-

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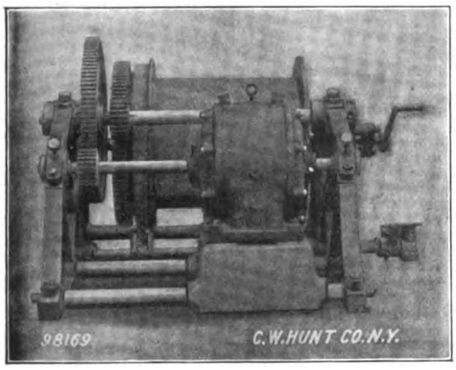
gines. Central stations may well look into the matter, as this sort of work would give them quite a profitable load were they to encourage the use of electric hoists among contractors and others now using the older types.

An equipment of this type of remarkably neat design is illustrated in the accompanying engravings. The motor drives the hoisting drum through a double reduction spur gear and a friction clutch which is operated by the upper handle. A band brake is set or released by a toggle joint of the differential type operated by a foot lever. These two controlling mechanisms give a perfect man-




AN ELECTRIC HOISTING ENGINE—SIDE VIEW.

ipulation of the load, the motor running at constant speed whether the load is rising, falling or standing still. The structure of the hoist consists of two solid side frames held together by distance bars. The bearings of the three shafts are let into these side frames and bushed with replaceable phosphor-bronze bushings. The gears are entirely under-hung between the two side frames, and the friction clutch is built so that it introduces no tendency to spread




AN ELECTRIC HOISTING ENGINE—END VIEW.

the frames. The machine shown in the illustration is equipped with the Westinghouse "type C" induction motor for alternating currents, but direct current motors may be fitted, the convenient support on the lower distance bars allowing for the ready fitting of any standard type.

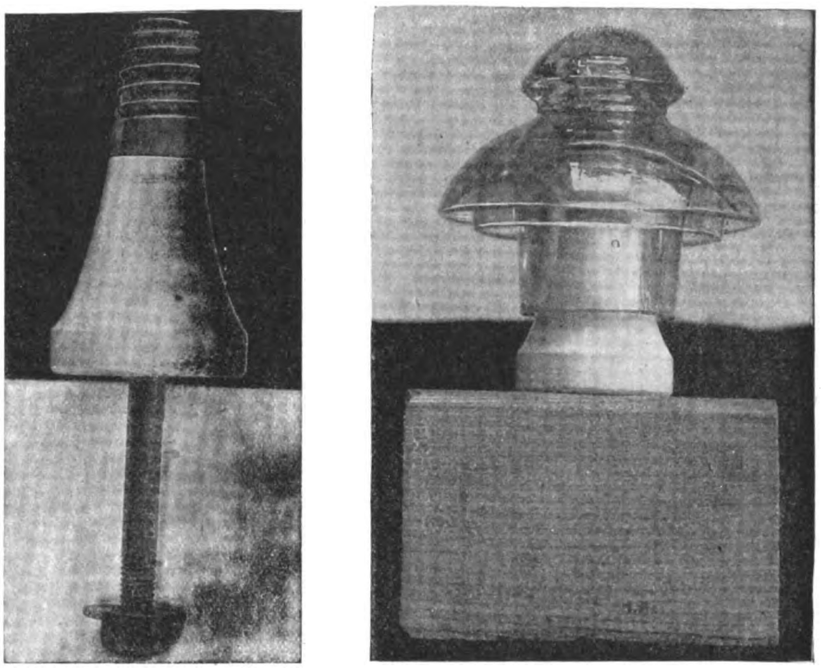
### HIGH TENSION INSULATORS.

The merits and defects of the porcelain insulator have been well shown up by the experience obtained with it during the last two or three years. The most recent designs show great improvements in overcoming the disadvantages of the earlier types.

The accompanying illustrations show the meritorious details of the insulators manufactured by Fred M. Locke, of Victor, N. Y. In order to avoid the strains brought about while cooling through unequal shrinkage of parts of different thickness these insulators are made up of two or three shells, one for each petticoat.

The cut shows the pin on which the insulator is mounted. It consists of a ½ in. galvanized steel bolt with a screw threaded top of wood boiled in paraffine, and a base of porcelain, which extends well up within the inner petticoat of the insulator and increases greatly the arcing distance between the rim of the insulator and the pin, preventing the destructive arcing and consequent burning off of pins, cross-arms, etc., and increasing greatly the voltage which may be carried on the lines.

There is also shown a glass insulator with eaves to carry the water away from the cross arm and a long inner petticoat coming well down over the porcelain base just described. This is designed for 25,000 volts, its diameter being 5½ ins. and weight 3 pounds. Another glass insulator 7 ins. in diameter weighing 5 pounds is put out for potentials from 22,000 to 50,000 volts.



AN IRON PIN WITH WOODEN TOP, PORCELAIN BASE AND GLASS INSULATOR.

### THE ROYAL ELECTRIC COMPANY'S INDUCTOR ALTERNATOR.

The design of machinery in general, and of electrical apparatus in particular, constantly tends toward greater solidity, simplicity, and the elimination of small detail attachments. The alternating-current dynamo is an improvement in this respect over the direct-current, and of the alternating-current types the revolving armature is inferior in this regard to the revolving field, and that in turn is inferior to the inductor type. There are now quite a number of different classes of the latter type, which, simple as it is, gives considerable scope for the ingenuity of the designer, a fact which will be evident from the improvements in the design of the machine of this type built by the Royal Electric Company, of Peoria, Ill.

Of the accompanying illustrations, Fig. 1 shows a 150-k.w. generator assembled. It exhibits the usual features of the inductor type, namely, the absence of all collector rings, brushes or exposed connections of any kind, and the concealment and protection of all parts of the machine, the pulleys and bearings excepted, within the yoke ring, and the end plates fitted to it. Fig. 2 shows the frame of the external stationary armature without coils. From this it is evident that the machine is of that class of inductor dynamos in which both polarities of the rotor are fitted with poles opposed by wound armature teeth, as distinguished from that class in which there is but one ring of armature teeth, the other polarity being a continuous ring, untoothed on the armature side and without poles on the rotor side.

The slots are approximately the same width as the teeth, giving ample room for the armature coils. The external ring is of cast iron, and the laminated teeth are attached to it by means of cast steel end plates of a toothed contour. There are two armature teeth for each pole of the rotor, and the dimensions are so chosen that the reluctance of the magnetic circuit is the same for all positions of the poles.

The space between the two rings of teeth is occupied by the field exciting coil, shown removed in Fig. 3. This has an external diameter smaller than the internal diameter of the armature teeth and fits down between the two rings of poles of the rotor, thus giving it a minimum ohmic resistance and waste of energy per ampere turn. The coil is short and deep—that is, of many layers and few turns per layer. It is

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wound upon a spool, the cylinder of which is of heavy copper to cut down the inductive rise of pressure on opening the field circuit, the sides of the spool being perforated to allow the ventilation of the field winding by the currents of air set in motion by the poles of the rotor. Fig. 4 shows the frame with both the field and armature windings in place, and the rotor removed. The armature coils are at their outboard ends joined by connectors, and may readily be connected up in series or parallel to give one or more of many different voltages.

Fig. 5 represents the inductor mounted between the bearings on the base of the machine. This rotating element is divided into three parts, one the central cylindrical core and the other two the rings carrying the laminated poles. These three parts are bolted together securely, and by simply loosening the bolts either ring may be removed to get at the corresponding armature windings or to remove the field-exciting coil. The poles are laminated to prevent the foucault currents which would otherwise be set up by the armature teeth.

The division of the armature coils into two separate rings allows the machine to be very simply transformed from a single to a two phase generator. This is accomplished by simply shifting one of the pole rings relatively to the other, so that the poles have a staggered relation, and dividing the circuits of the two rings of armature teeth. One of these then generates an electromotive force displaced in phase from that of the other. The necessary holes are provided in the center core of all machines, so that this change can be quickly made.

The magnetic density throughout the whole circuit is low, no point running above the bend of the magnetization curve. The air gap between the rotating and stationary elements is comparatively large, and although this condition increases considerably the cost of manufacture it has been adopted for mechanical reasons, as well as to reduce the armature reaction and give close automatic regulation without the complication of a rectifier and compound winding. The regulation obtained is within 2 to 7 per cent., depending on the size of the machine.

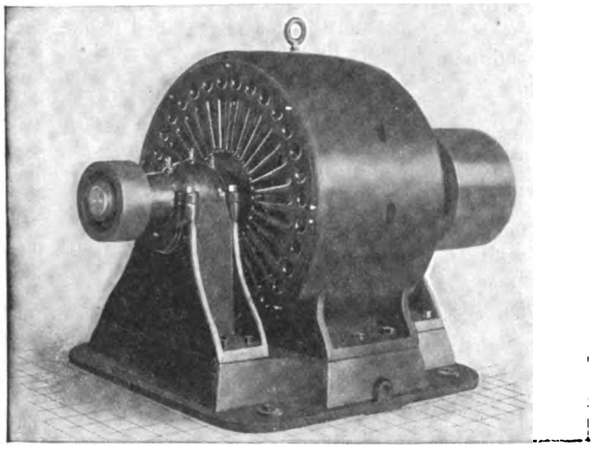


FIG. 1.—A 150 K. W. INDUCTOR GENERATOR.

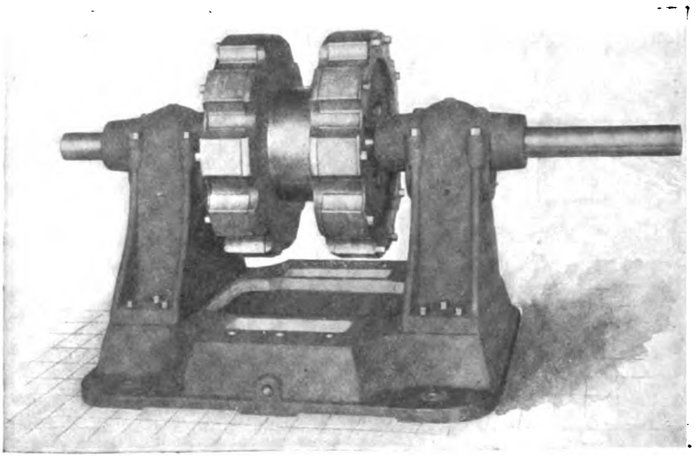


FIG. 5.—ROTOR OF INDUCTOR GENERATOR.

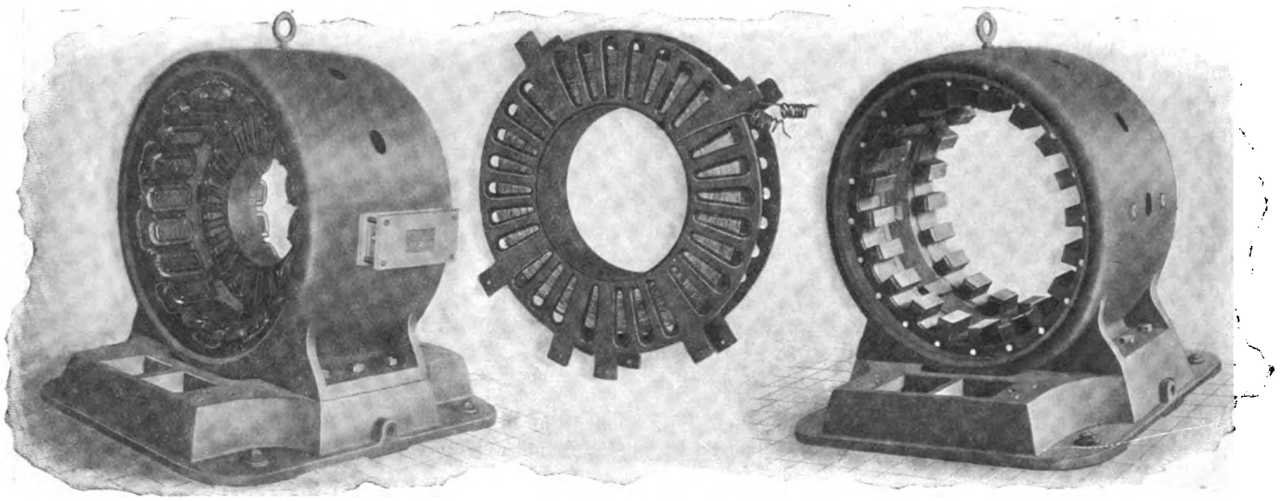


FIG. 4.—FRAME WITH WINDINGS IN PLACE. FIG. 3.—EXCITING FIELD SPOOL. FIG. 2.—FRAME OF EXTERNAL STATIONARY ARMATURE.

## AN UP-TO-DATE HYDRAULIC DAMPER REGULATOR.

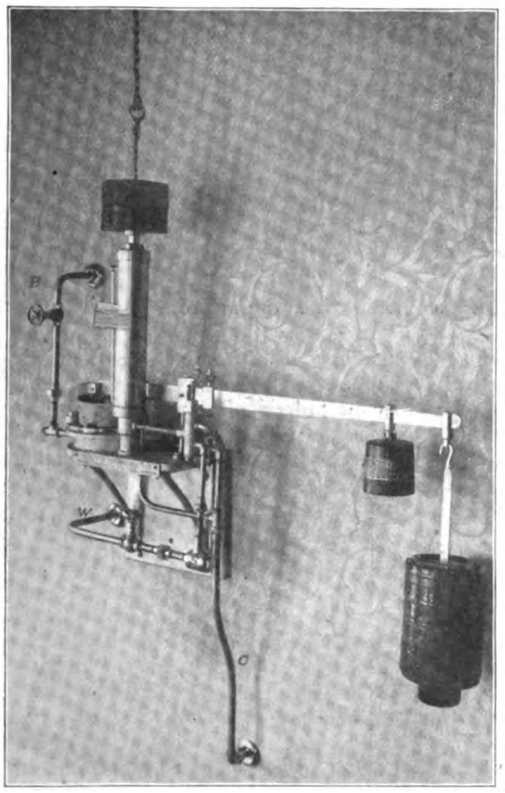
The automatic control of the draft of steam boilers is now recognized to be superior to the comparatively careless control given by the average fireman. A damper regulator that will respond to the slightest variation in the steam pressure is just as essential an adjunct for controlling the work of a boiler, as is the governor for controlling a variable load on an engine. The uniformity in steam pressure and in the temperature of the furnace, which is attained by close regulation through an improved automatic damper regulator, is necessary to the highest efficiency for the boiler. To attempt to economize in fuel consumption or to maintain a uniform steam pressure by manipulating the dampers by hand is as difficult as trying to get a uniform engine speed with the old-style plain throttle valve. The large saving constantly effected in fuel by the use of hydraulic damper regulators is so well established that now it is universal custom among consulting engineers and architects in this country to specify hydraulic damper regulators in boiler plant specifications.

The accompanying illustration shows a Patterson's improved hydraulic damper regulator, an up-to-date machine for handling from one to twenty boilers. All of the parts of the apparatus have been carefully designed from a scientific and engineering standpoint, and it is claimed that for simplicity of construction, compactness, neatness in finish and sensitiveness in operation, it is superior to any yet put upon the market. It is guaranteed that a change of one-half pound in the boiler pressure will open or close the heaviest dampers. It will also give a partial movement to the damper, moving it from time to time in sympathy with the slightest change in the steam pressure.

In the Fig. B is the steam pressure con-

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nection taken from the boiler which acts on the diaphragm and causes the diaphragm lever to move upward or downward less than one-sixteenth of an inch. W is the water supply for motor, S is a strainer to prevent floating matter from getting to the damper water valves. By unscrewing the cap at the end of this strainer foreign matter can be removed without breaking



HYDRAULIC DAMPER REGULATOR.

pipe connection. The overflow pipe for carrying off the discharge water from motor is shown at O.

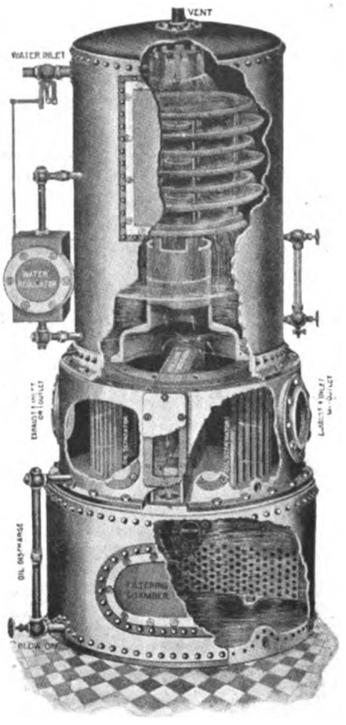
The apparatus is made by The Patterson Damper Regulator Company, of Baltimore, Md., and was designed by Mr. George F. Patterson, the President of the company, who has had wide experience with damper regulators.

### THE COOKSON IMPROVED FEED-WATER HEATER, PURIFIER, FILTER AND OIL SEPARATOR.

Unfortunately for steam users, the steam boiler is a mammoth still. Every pound of water that enters it comes in in liquid form and goes out as a vapor, leaving behind all impurities, oil, lime or whatever else may have been in the feed-water. Any impurities which are in the feed-water thus accumulate and eventually result in the destruction of the boiler. The purification of the feed-water is therefore a matter of most vital importance.

A feed-water purifier, which is also a heater as well as an exhaust steam oil separator, is manufactured by the Bates Machine Co., of Joliet, Ill., the latest improved type having many interesting details. One of these heaters rated at 500 h.p. is shown in the accompanying illustration, parts being indicated broken away to show the internal construction.

The structure is built up of cast iron and steel plates, with parts interchangeable for easy duplication and assembled in such a manner that it can be taken entirely apart with a monkey wrench. The top section is of steel plate, the centre section of cast iron in a single piece including the shell, top and bottom heads and internal parts, while the bottom section or filtering chamber is made with




THE COOKSON FEED WATER HEATER.

a heavy cast iron bottom and a cast ring at the top, to both of which the steel shell is riveted. In heaters of smaller sizes than 300 h.p., this lower chamber is built of cast iron. The three sections are securely bolted together with special gaskets.

The operation of the heaters is as follows: Exhaust steam may be introduced from either side and discharged from the other. Steam entering from the right side, as shown, strikes the V-shaped oil separating plates, which purify it, the ribs on these plates separating the water and oil from the steam. The latter then flows over the central hollow partition and down through the V-shaped plates on the other side and out through the exhaust outlet to the atmosphere or the heating system. Thus all steam passing through the heater is purified of oil, but only that needed for heating feed-water is taken off from the main flow, the balance passing straight through without being cooled, so that its heat may be available for other purposes.

At the top of the heater is a vent pipe for carrying off the air and gases relieved from the water in heating. The cold water supply from the city main or tank enters in a spray and condenses the steam, forming a partial vacuum, which draws the required amount of steam to heat the water up the large tube in the centre. But only that amount of steam necessary to heat the water comes in contact with it, the balance passing on in its dry purified state to the heating system or atmosphere.

The water supply is connected to the water inlet valve which is opened and closed by the water regulator, maintaining at all times a uniform water level in the heater. The water entering the spray box at the top of the heater overflows in a spray to the pan below, and the overflow from this pan sprays into the next. The water passes from this second pan through its centre to the next pan below, and so on down. The last pan is bolted to the top of the exhaust tube. The spray falls from this pan to the water level below. All pans, with the exception of the bottom one, are loose, made in halves, and are readily removable from the manhole. The object of these pans is to catch the lime deposit.

The water, having been heated in direct contact with the steam, enters the hollow partition across the exhaust tube and discharges into the filtering chamber below, where the remaining impurities in suspension are removed by filtration. It is obvious that the water in the hollow partition is kept at the boiling point by having steam on both sides of it all the time. The filtering chamber is filled with coke or excelsior and at the back of this chamber is a perforated plate preventing the filtering material from passing through to the pump. A strainer plate is also placed at the blow-off connections. The two oil separating chambers are connected by a small opening through the hollow partition at the bottom, through which the oil and condensed water drain from one chamber to the other. All chambers are provided with large manholes and handholes for cleaning. The manhole in the upper chamber is hinged, making it an easy job to open the heater for examination and the removal of the lime catching pans. Exhaust flanges, suction and return flanges are also removable, and a heater will be furnished with any sized flanges desired up to the capacity of the heater. The water inlet valve is balanced, having a double valve, and is made entirely of brass. The water regulator contains a seamless copper float, and all connections, stuffing boxes, etc., are of brass, to prevent corrosion.

The Bates Co. has just issued a large lithograph of this improved Cookson Heater, which will be mailed to any address on application.

### THE HARRISBURG STANDARD SELF-OILING ENGINE.

The name of the Harrisburg Foundry & Machine Works, of Harrisburg, Pa., has long been a familiar one to steam users, through their engines, known as the "Ide" and "Ideal." More recently a new type known as the "Harrisburg Standard" has been evolved from the experience had with the other engines, and these three engines may now be known in their order as good, better, best, the standard embracing all the good points of the others, as well as some of its own.

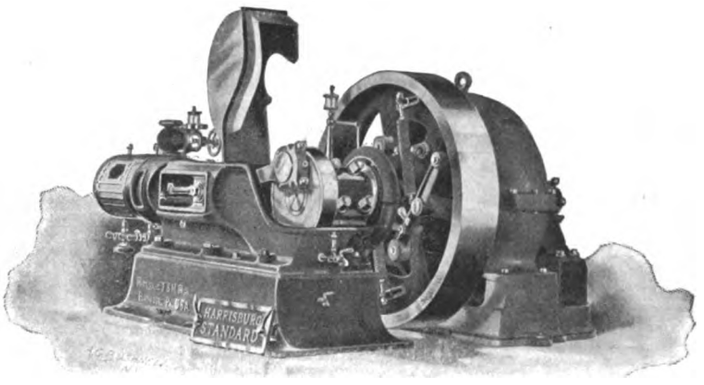
The "Harrisburg Standard System" of

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engines includes simple engines, tandem compounds with single valves, and simple, tandem and cross-compound engines with four valves, medium and slow speed, the latter of the Corliss rocker type.

A peculiar feature of these engines is that they are all constructed with side cranks, requiring only two main bearings, whether designed for direct coupled or belted service, and thus many of the disturbing elements (excessive friction and bad alignment) that attend the operation of three or four bearing engines are removed, the friction in these machines being in many cases as low as 2 per cent.

The simple engine, which is made in sizes up to 36 ins. in diameter and stroke, is compact and graceful in design, as will be noted by the accompanying illustrations. Its salient features include an automatic oiling chamber, by which the crank disc, connecting rod and cross head are enclosed, being provided with a hinged hood which may be turned back, and a plate on the side which may be easily removed for inspection and adjustment of the reciprocating parts. By the revolution of the disc in oil, the rim of the disc touching its surface, it is splashed over the wearing parts including the cross head, and by means of a lateral internal trough across the inside of the cover, a large portion of the oil is led out through a pipe and directed in a stream upon the main bearing adjoining the crank disc. The lubrication of the crank pin is accomplished in a very ingeniuos manner, by means of an annular chamber, recessed in the face of the disc around the main shaft next to the main bearing, from which a diagonal hole is drilled through the disc, coming out about the middle of the surface of the crank pin, so that by centrifugal force a constant volume of oil is provided for its lubrication, completing the circulation from the reservoir to cross head, main bearing, crank pin, and finally draining to reservoir again.



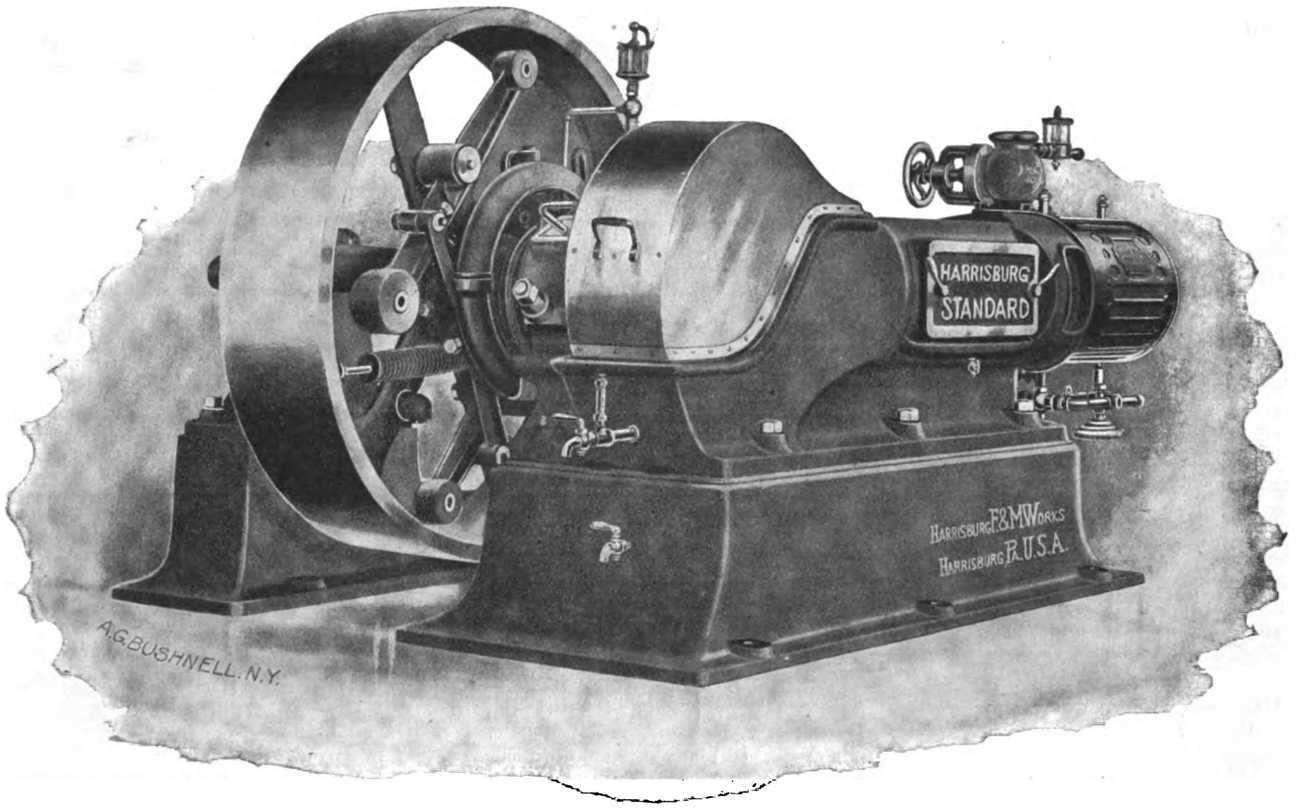

THE HARRISBURG ENGINE COUPLED TO A GENERATOR.

The patented governing mechanism is also a special feature of these engines, and is of the fly wheel, technically termed centrally balanced, centrifugal-inertia type; it is sufficiently sensitive to regulate to one-half of one per cent. in load variations from zero to 125 per cent. Rollers are provided in the governor bearings.

The pillow blocks of the crank shaft have the covers fitted in a diagonal position, and the shell is provided with an oil chamber with recesses for the oiling chains. The engine frame is extended with a stuffing box exposed in such position as to provide for constant and easy access, its purpose being to prevent the water of condensation from getting into the oil supply should a leak occur. The oil is prevented by a guard from getting on the piston rod.

In the process of manufacture, the pistons, piston valves, pins and other special parts are all ground to an accurate fit, and micrometer records made of each piece, so that any part of an engine can be duplicated at any time after it leaves the works. The crank disc, including the pin, is cast in one solid piece of steel, the mould being placed in a horizontal position, with the pin down, producing a dense metal in the pin. This is afterwards turned and properly fitted, when the disc is shrunk on the shaft and keyed in position.

Every engine is thoroughly tested be-




THE HARRISBURG ENGINE, SHOWING GOVERNOR AND OILING CHAMBER.

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fore it is shipped, and for this purpose metal bed plates on heavy masonry are provided, with suitable channels for clamping the engines in place. When in position for testing, the engine bed is supportetd on metallic points, and the machine is first run for adjusting the governing and valve mechanism. Next, the fiy wheel is accurately corrected to a running balance, and finally each engine is so perfected that it is run upon the metallic points without any fastening.

Although the "Harrisburg Standard Engine" was designed but a year ago, there are already in operation nearly one hundred of these machines with orders for thirty more in the shop.

The Harrisburg Foundry and Machine Works also manufacture road rollers to a considerable extent, as well as tubular boilers, and in order to meet the growing demands of their trade, are erecting extensive new shops at West Harrisburg, for which the walls and stacks are nearly up. The ground dimensions of the main building are 300 ft. x 140 ft., and it is intended that all departments, including the foundry, shall be under one roof. The designs show that this is to be an up-to-date establishment in every particular, and the equipment will embrace the latest improved machinery suited to this class of work.

The power equipment will consist of two "Standard" four-valve engines, direct coupled to two direct-current generators, each of about 75 kw. capacity. The different sections of shafting are to be driven by electric motors, and there will be electric cranes and hoists, together with a trolley shifting locomotive, which will communicate with the different departments outside of the building.

The affairs of the company are under the management of Mr. W. R. Fleming, who was induced to give up his engineering business in New York for this purpose and who has had much to dó with the designing of the "Standard' engine. Mr. Fleming took charge of the company's affairs January 1st, 1898, since which time the output of the establishment has shown an increase of 45 per cent. over the previous year.

## OBITUARY.

CAPTAIN SAMUEL TROTT, a well known inventor and expert in the laying and repairing of submarine cables, died of heart disease in Florida, March 11th, at the age of sixty-seven years. Captain Trott was born in England and took to the sea at the age of seventeen, becoming a master at twenty-seven. He had command of the cable laying steamer Faraday from 1874 to 1880, during which time he laid several trans-Atlantic cables and made many remarkable repairs in mid-ocean.

Captain Trott assumed command of the cable repairing steamer Minia in 1880, and retained the command until his death. He was the joint inventor of a new type of deep sea cable, and was the sole originator of an electric grapnel, which is now in very general use, the electric mechanism being such that a bell is rung on the cable steamer whenever the prongs of the grapnel come in contact with the cable. Just previous to the outbreak of the Spanish war he laid the cable connecting Key West and the Dry Tortugas for the United States government.

EDWARD SMITH TABER, president and treasurer of the Morse Twist Drill and Machine Company since 1868, passed away at his home, in New Bedford, Mass., on the tenth day of March, 1899, aged 73 years.

Called to the position of president when the company was in its infancy, he filled it long and faithfully. While adverse to taking upon himself the credit for this success, his associates are most glad to attribute a large measure of the general prosperity of the company to his untiring efforts, his faithful activity and his skill as a director.

His services were in demand by other business interests of New Bedford, and for many years he served as a trustee and member of the board of investment of the Institution for Savings, and for the past eighteen years was a director of the First National Bank, in addition to serving for the past nine years as its president.

A type of the older school of business men, whose very presence inspired confidence, Mr. Taber was held in the highest respect and esteem not only by those associated with him, but by the community at large, and he made himself a power in New Bedford's general business circles and exercised that power with conservative judgment.

## PERSONALS.

MR. EDWARD L. COOLEY has been appointed manager of the Boston office of the C. & C. Electric Co., 19 High Street, Boston, Mass., the position formerly held by Mr. William F. Palmer. Mr. Cooley was formerly located in Boston, but has been for a number of years in Philadelphia with the General Electric Co. He has made a large number of friends, who regret to see him leave.

MR. GEORGE W. BROWN has retired from the general management of the Belknap Motor Company, Portland, Me., to give his whole attention to the management of the Cumberland Illuminating Company, of North Gorham, Me. Mr. Brown will be succeeded by Mr. E. E. Furnald, who has been so long connected with the Belknap Company as superintendent.

MR. F. D. KILLION, for the past twelve years connected with Messrs. Walker & Kepler, of Philadelphia, in the capacity of a traveling salesman, has accepted a similar position with the Franklin Electric Supply House, of Philadelphia, and has already entered upon his new duties. Mr. Killion's territory will be the States of New York, Pennsylvania, New Jersey, Delaware, District of Columbia and eastern Ohio. As Mr. Killion has been in the electrical business since 1881 he naturally has a great many friends in the business who will be glad to see him in his new position, and will undoubtedly favor him with a fair share of their business.

## TRADE PUBLICATIONS.

THE "PAN-AMERICAN" is a new weekly journal, published in Buffalo, N. Y., that will be devoted to the affairs of the Pan-American Exposition to be held in Buffalo in 1901.

THE ROBBINS & MYERS COMPANY, of Springfield, Ohio, has issued, besides its regular catalogues of its Standard ceiling and "Search-Light" fans, a book of testimonials reproduced by the photo-engraving process from the actual letters of users of the Standard fans.

THE WESTERN ELECTRIC COMPANY, Chicago, in addition to its forty-page fan motor catalogue, is issuing a series of four-page bulletins descriptive of the different styles of fans. Bulletins 16 F, on W. E. standard ceiling fans and 17 F, descriptive of desk and bracket fans for direct currents, have just been issued.

"THE HORSELESS AGE," the journal representing the automobile industry, will hereafter appear as a weekly instead of, as formerly, a monthly paper, the growing importance of the business it represents having warranted this change. The offices of the paper have also been moved to the American Tract Society Building, of New York City. The "Horseless Age" is a publication of no little value and interest to those electrical engineers who are interested in electric vehicles.

## BUSINESS NEWS.

G. W. HOFFMAN, of 295 East Washington Street, Indianapolis, reports an order for a carload of the U. S. infallible metal polish paste for export.

THE SMITH & HEMENWAY COMPANY, of 20 Warren Street, New York, has bought the hardware branch of the business of the Maltby-Henley Co.

THE WARD LEONARD ELECTRIC COMPANY, Bronxville, N. Y., profiting by its experience in the construction of enamel rheostats, has engaged in the manufacture of enameled iron signs.

THE KEYSTONE ELECTRICAL INSTRUMENT COMPANY, of Philadelphia, has recently opened a New England office at 170 Summer street, Boston, which will be in charge of Mr. F. B. Smith.

MESSRS. BRYAN & HUMPHREY, the well known consulting mechanical and electrical engineers of St. Louis, Mo., have moved their offices from the Turner building to the Lincoln Trust building in that city.

PROFESSOR J. W. TROTTER has placed with Messrs. Goldmark & Wallace, of New York, the exclusive right to handle his commutator compound. They will mail samples free of charge to any address and all orders will receive prompt attention at their hands.

THE WESTERN ELECTRIC COMPANY, Chicago, prior to the recent rise in copper, greatly increased its stock of rubber-covered wire, and is prepared to meet the demand of the spring trade with reasonable prices and prompt shipments.

THE CUTLER HAMMER MANUFACTURING COMPANY., of Chicago, has opened an eastern office at 136 Liberty Street, New York City, where it will carry a large stock of rheostats. The office will be in charge of Mr. W. H. McGregor.

THE KNAPP ELECTRIC & NOVELTY CO. has moved from its former address of 47 Warren Street to a new building at 125 White Street, New York City. The facilities for turning out work in the new location are practically double those in the old.

A NEW MICA FACTORY.—Eugene Munsell & Company, of New York and Chicago, have recently determined to establish a mica factory in Ottawa, Ontario. The plan is to forward the mica direct from the mines to the new factory, where it will be treated, sorted and prepared for shipment to New York.

CREOSOTED WOOD PIPES make good conduits for drawing in underground cables. They are not brittle, and their deterioration is astonishingly slow. The Michigan Pipe Company, Bay City, Michigan, makes such ducts in convenient 8-foot lengths, treated by the Bethel process.

JAMES G. BIDDLE, formerly of 910 Drexel Building, Philadelphia, Pa., has moved his office to Room No. 1088 of the same building. Fortunately for all interested in electrical instruments, the new location is so near the old one that there will be no difficulty or delay in finding Mr. Biddle or reaching him by mail.

DISSOLUTION OF PARTNERSHIP.—The partnership heretofore existing between Messrs. John Y. Parke and Thomas J. Allen, under the firm name of John Y. Parke & Co., of Philadelphia, was dissolved on March 10 by mutual consent. The business will be continued by Mr. John Y. Parke under the old title.

THE DAYTON GLOBE IRON WORKS COMPANY, Dayton, Ohio, is meeting with exceptional success with its gas engine for electric lighting purposes. Many testimonial letters have been received from users of its engines and they all unite in agreeing that

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the engine is giving wonderful regulation and efficiency, and general satisfaction is universally expressed.

CHAPMAN VOLTAGE REGULATOR.—Among the recent sales by the Belknap Motor Company of Portland, Me., are a No. 1 regulator for a General Electric alternator in the plant of the Montmorency Electric Power Co., Quebec; a No. 2 alternating regulator for the Fort Wayne Bamp Co., Ft. Wayne, Ind., and a No. 1 alternating regulator to J. S. Viles, Middlesex, Vt.

THE WIRT DYNAMO BRUSH has been reduced in price, as is shown by a new list of the manufacturer, Mr. Charles Wirt, 1028 Filbert Street, Philadelphia, giving a general reduction in the prices of all brushes. These changes, at a time when the cost of metals is moving in the other direction, are warranted by the reduced cost of manufacture consequent upon the increased scale of operations.

MESSRS. EYANSON & ARMPRIESTER of Philadelphia have shipped three large switchboards to London, England. These boards are a part of the equipment furnished by Messrs. Eyanson & Armpriester for the large electric fountain being built for the Crystal Palace Park Co. from designs by F. W. Darlington. The same firm is at work on switches to be shipped in a few weeks to Milan, Italy.

THE PITTSBURG TRANSFORMER CO. reports a very rapid increase in the demand for its transformers, its business during the first seventeen days of March being double that during the months of January and February combined. The popularity of this transformer is not local, as is shown by shipments during one week to California, the Dakotas, Illinois, New York and Maine, besides those to nearby territory.

THE STANDARD THERMOMETER AND ELECTRIC COMPANY, Peabody, Mass., has opened an office in the Washington Life Building, Broadway and Liberty Street, New York, under the management of Mr. Wm. J. Bramhall. The company has also opened a Chicago office at 313 S. Canal Street, Chicago, which will be in charge of Mr. Geo. H. Stout, who has been for many years identified with the arc lamp business of the West.

AN ELECTRIC GAS IGNITER for Welsbach burners is the latest thing put on the market by the Electric Appliance Company, of Chicago. The convenience of the electrical igniter is even greater on the Welsbach flame than on the ordinary fish tail gas jet, as the Welsbach must be lighted from above, a position often difficult to reach, and when lighted with a match starts with a small explosion. The new electrical igniter is fitted with a key extending downward, making it a more handy device than even the usual chains.

THE CENTRAL ENERGY INDEPENDENT TELEPHONE APPARATUS, made by the Stromberg-Carlson Telephone Mfg. Co. of Chicago, is in such great demand that the company will soon enlarge its factory to more than double the present capacity. Some switches under construction by this company, which compare favorably in magnitude as well as other features with the largest and best Bell boards, are two with a capacity of 5000 subscribers in St. Paul and Minneapolis, and one with a capacity of 1500 subscribers for Waco, Texas.

THE FEEDER AND HIGH TENSION CABLES for the mammoth system of the Third Avenue Traction Company of New York City have been ordered in part, contracts aggregating $400,000 having been placed. These include 300,000 feet of one million c. m. paper insulated Roebling cable and 80,000 feet of rubber covered 0000 three conductor cable for the high tension three-phase system. The orders for the high tension cable were divided among the General Electric Co., the Safety Insulated Wire & Cable Co. and the John Roebling's Sons Co.

A REMARKABLE ENGINE RECORD.—The Murray Iron Works of Burlington, Iowa, had one of their 24x48 Sioux Corliss engines at the Omaha Exposition that made a run probably without precedent in stationary engine practice. It was operated 24 hours per day for 50 days, or 1200 consecutive hours, with only one stop of 30 minutes. For 80 days it ran 23 and 24 hours per day, as the authorities desired, and its total run was 2983 hours in 155 days, an average of more than 19 hours per day, from the dull days at the start to the rush at the finish.

THE "CRITERION" ACETYLENE GAS GENERATORS are meeting with a constantly growing demand, according to J. B. Colt & Co., 3-7 West Twenty-ninth Street, New York City. They report a recent order for sixty of these machines to be shipped abroad and an increasing demand generally throughout this country. The "Criterion" meets the approval of every prominent fire insurance board of underwriters in the United States, and embodies in its design and construction features that insure the most desirable results in the use of acetylene gas for household and commercial purposes.

JAMES LEFFEL & COMPANY, of Springfield, Ohio, manufacturers of water wheels and automatic engines for electrical purposes, state that they have been compelled recently to double their foundry capacity to enable them to meet their largely increased trade. They have recently installed a new three-motor traveling crane of 50 tons capacity and a new G. E. generator for power and lighting purposes. Leffel water wheels are now known and used all over the world and enjoy a reputation second to none. The increased trade of this company will be noted with satisfaction by its many friends.

MR. W. G. AMOS, Chicago representative of the Murphy Iron Works, of Detroit, Mich., has recently closed an order for four Murphy automatic smokeless furnaces to be installed in the Western Electric Company's plant in Chicago. It is stated that these furnaces are to supersede another type of furnace manufactured by another company. The company claims that the superiority of the Murphy furnace has been repeatedly demonstrated many times in competition with other makes and that the purchasers of the Murphy furnace are always assured that they have obtained a most complete, modern and economical furnace.

THE OUTPUT OF WESTINGHOUSE OIL INSULATED TRANSFORMERS.—The growth of the demand for the Westinghouse Company's transformers of the oil insulated type has been something phenomenal. During the year 1895 there were installed transformers with a capacity aggregating 560 h. p., 1896 17,000, 1897 30,633 and 1898 90,000 h. p. The total output up to January 1st, 1899, aggregated 146,540 h. p. It is expected that the present year will show a record for which the previous years will present no parallel, as one single order has already been placed for 17,500 h. p. in seven transformers rated at 2500 h. p. each, larger than anything heretofore ever constructed.

THE HOPPES MANUFACTURING COMPANY, 67 Larch St., Springfield, Ohio., is building two live steam purifiers, each of 250 h. p., for the Deering Harvester Company, Chicago, and has sold in addition three 1000 h. p. purifiers, to be installed in the Kings County Light and Power Company's plant and three 625 h. p. to the Louisville Street Railway Company, Louisville, Ky. The orders from the Deering Harvester Company and the Louisville Street Railway Company are both repeat orders. The Hoppes Manufacturing Company has recently, through its London agent, Robert W. Blackwell, 39 Victoria St., Westminster, London, sold a 625 h. p. purifier and two six-inch vertical separators.

THE GARTON-DANIELS ELECTRIC COMPANY, Keokuk, Iowa, has issued an illustrated catalogue of various types of Garton-Daniels lightning arresters and the auxiliary devices, such as kicking coils, etc., to be used with them. The Garton-Daniels Co. claims that the usual winter dullness has been conspicuous for its absence during the season just closed, owing to the receipt of many large orders for export. In January nearly 80 per cent. of the company's shipments have gone abroad.

The company has also doubled its force in order to keep pace with the spring demand for its goods, but still finds that it is shipping faster than it is manufacturing, and this in spite of the fact that it had on hand at the beginning of the season twice as large a stock as ever before. Additional force will be employed, however, so that all orders will be filled with the usual promptness.


# A COMMUTATOR NECESSITY.




**The Only Article that will Prevent Sparking.**
**Will keep the commutator in good condition and Prevent Cutting.**
**Absolutely will not gum the brushes.**
**It will put that high gloss on the Commutator you have so long sought for.**

**50c. per Stick. $5.00 per Dozen.**

**For Sale by all Supply Houses.**

**Upon receipt of this coupon we will send FREE, sample stick.**

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**Sole Manufacturers,**
**909-100 Washington Street, CHICAGO.**


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THE CLING-SURFACE MANUFACTURING COMPANY, Buffalo, N. Y., is to be congratulated on the results of tests recently made by Prof. R. C. Carpenter on belts treated with Cling-Surface. The tests were made on the belt-testing machine of Sibley College to determine the horse power which a given belt would transmit without excessive slip with different initial tensions. One 4-in. belt was tested before and after treatment with Cling-Surface. The results showed that with Cling-Surface the horse power which could be transmitted was greater with the lower values of initial tension than with the higher, showing that initial tension, with its resulting strain on journals, wear and tear of belts, etc., is absolutely unnecessary in belts treated with this compound.

THE AMERICAN DISTRICT STEAM COMPANY, of Lockport, N. Y., has contracted for a large extension of the steam mains of the Danville, Ill., Gas, Electric Light and Street Railway Co. The experience of the latter company in the sale of exhaust steam for the past four years has been very satisfactory, so that it is ready to respond to the demands of people for an extension of its heating district to parts of the city not now reached. The Wilkinsburg Electric Co., near Pittsburg, Pa., has also contracted with the American District Steam Co. to lay more than two miles of steam mains for heating the town with exhaust steam. The district to be heated consists mostly of fine residences, which are now being heated with natural gas. The company expects to compete successfully with the natural gas supply.

THE SIXTH ANNUAL REPORT of the Board of Electrical Commissioners of South Norwalk, Conn., has just been issued. It will prove of special interest to towns considering the question of establishing their own particular lighting system. It gives in detail the complete cost of the installation, together with detailed statement of the running expenses. So many indefinite and vague statements are made in regard to the cost of running municipal plants that the clear, detailed and reliable report of South Norwalk will be particularly valuable. A good word is said for the Watertown engines and boilers, manufactured by the Watertown Engine Company, of Watertown, N. Y., and the Siemens & Haske electrical apparatus, which form important features in the new plant.

A GOOD INDICATION OF PROSPEROUS TIMES.—The Bullock Electric Manufacturing Company moved into its Norwood plant in December, and at present, although increased facilities have more than trebled its output, it has so much work ahead that it has recently begun working night and day. When this firm had its factory at Hunt and Broadway, Cincinnati, it was recognized as one of the large electrical establishments of the country. The Bullock Company states that its new plant at East Norwood, Ohio, is, next to those of the General Electric Company and the Westinghouse Electric and Manufacturing Company, the largest electrical establishment in America, and that no plant is as well equipped with facilities for turning out work and modern conveniences in machine shop practce. All the machine tools are driven with individual motors, and the entire absence of belts and shafts makes it a novel factory, which is well worth a visitor's time to inspect, even if he is not especially interested in machine shops.

THE "NEW STANDARD" DRY BATTERIES.—The United States navy has a way of getting the best there is on the market, or if this does not meet its requirements, of getting manufacturers to make something that will, unless it is a physical impossibility. Just one year ago the navy asked Mr. William Roche, 259 Greenwich Street, New York City, for quotations on a special primary cell for gun firing, etc. The requirements were an e. m. f. of 1.40 volts and an internal resistance less than 3 ohms. The cell designed to fill these specifications has since become known as the "Navy Special." The require-

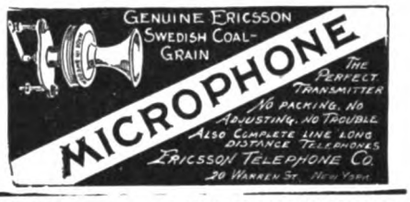

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THE BURT MFG. CO.
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Will Outlast Several Ordinary Valves. TRY THEM.

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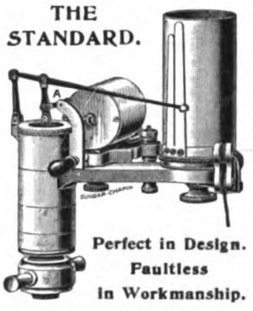
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Perfect in Design. Faultless in Workmanship.

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FLICKERING of lights usually occurs when the station is being crowded. It is self-evident that this flickering is caused by the slipping of belts, and as a belt full of CLING-SURFACE runs steadily and positively beyond all possibility of slipping, the importance of this fact can be readily seen.

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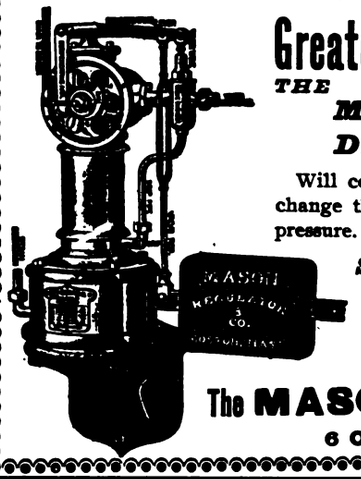

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ments have since been raised to a pressure of 1.47 volts, with an internal resistance not more than 0.3 ohm. Mr. Roche claims, however, that the cell as now made will give 1.53 volts and has an internal resistance less than 0.12 ohm. The value of such a cell for telephone and other purposes is obvious. On May 1st Mr. Roche's place of business will be moved to 42 Vesey Street, New York City.

THE INTERNATIONAL CORRESPONDENCE SCHOOLS, of Scranton, Pa., are doing a work the magnitude of which is quite astonishing. Instruction is now given in 52 engineering trades and professions, as well as in the elementary branches of business college work. Seventy-five thousand students have been enrolled, over 40,000 of whom are now studying. These students represent over 250 trades and professions, and reside in 65 different countries. There are 14 schools, among which are those of mechanical engineering, steam engineering, electricity, mines, architecture, etc., known collectively as "The International Correspondence Schools." They are owned by "The Colliery Engineering Company," proprietors of "The Colliery Engineering and Metal Miner," a publication from the educational department of which the schools sprang. Over 1,000 persons are employed in the instruction and business departments of the institution, whose success marks one of the most remarkable educational advances of the nineteenth century.

THE LIBERTY LAMP COMPANY, which has removed from its old location in Boston, to Malden, Mass., has now largely increased facilities for manufacturing incandescent lamps. The company, which was then a partnership composed of Mr. E. McOuat and Mr. W. W. Scott, started in business in the Fall of 1897 in Boston, but owing to the increased demand for Liberty lamps found its facilities inadequate to supply the trade. In November, 1898, it moved to Malden, Mass., where it is at present located, and has facilities for an output of 5,000 lamps per day. Its success in business can be largely attributed to the long and varied experience of both the gentlemen mentioned in the manufacture of incandescent lamps. Mr. McOuat first started in with the old United States Co. in 1880 with Edward Weston, afterwards being connected with the Sawyer Mann Co. in New York, and also the Westinghouse Co. in Pittsburg and the Beacon Lamp Co. of Boston. Mr. Scott started with the Westinghouse Electric Co. of Pittsburg in 1885, and after seven years severed his connection with that company and came to the Beacon Lamp Co. of Boston, Mass.

THE DEMAND FOR FILER & STOWELL ENGINES has become so great that arrangements are now being made to double the capacity of the Filer & Stowell Company's foundry at Milwaukee, so as to get out the necessary castings to keep all of the tools in the machine shop running day and night. The engine orders now on this company's books are sufficient to supply its engine departments with work for the next six months. Among the most prominent engines ordered may be mentioned: A 2000 h. p. cross compound, to be shipped to the home of the Corliss engine, Providence, R. I., for the Union Railroad Company of that city. The fly wheel of this engine is to weigh 100,000 lbs., and to have a cast steel ring 6 inches thick shrunk on the rim. This ring will be 24 feet in diameter, made in one piece, and must be shrunk on after the wheel is in position. Another 2000 h. p. cross compound is now under erection for the Armour Elevator Company of Chicago. Of cross compound engines rated at 1000 h. p., one has been ordered by the Edison Electric Light & Power Company of Erie, Pa., and two, which are to furnish the power for the generators at the central station of Armour & Co., are now under construction. These last two make in all ten engines which Armour & Co. have ordered from this company within the last two years. Besides the above the Filer & Stowell Company has received within the past sixty days orders for 26 large engines, two of which are to go to Huntsville, Ont., one to the city of Vera Cruz, and eight to Mexico.


**Greatest Fuel Saver on Record.**

THE
***MASON HYDRAULIC DAMPER REGULATOR.***

Will control one boiler or a battery. Guaranteed to change the damper on the slightest variation in steam pressure.

***SIMPLE, POWERFUL, RELIABLE.***

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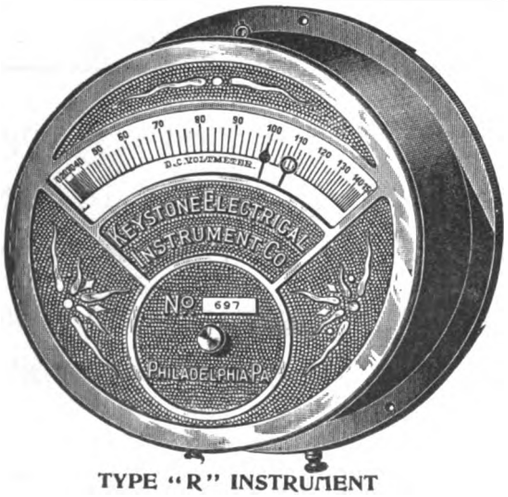
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**Our instruments are constant and durable, sensitive and accurate, pleasing in appearance and always correct.**

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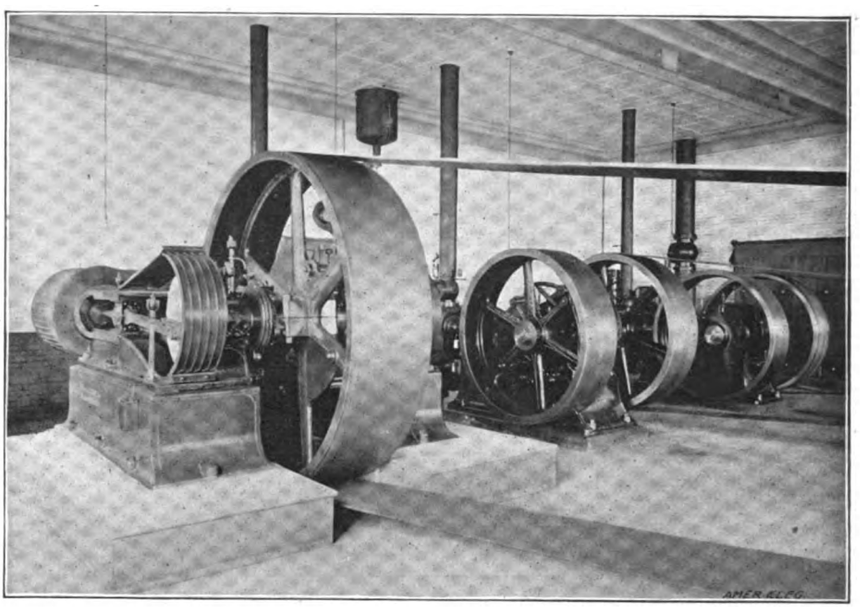
# American Electrician.

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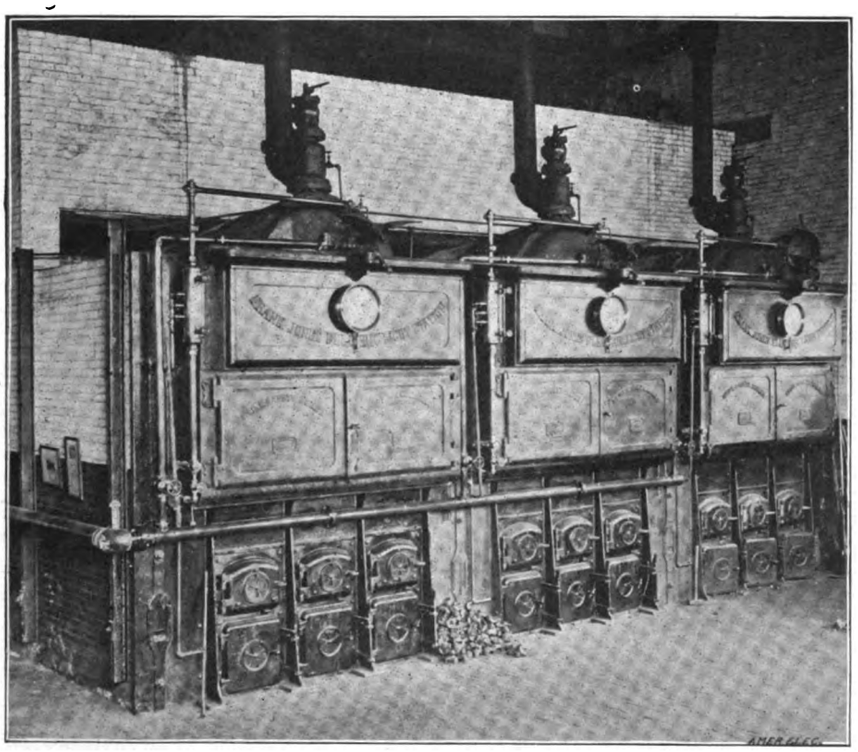
## A PRIVATE CENTRAL STATION.

### A MONOCYCLIC ISOLATED PLANT.

There are in this country, notably in the large steel works of Western Pennsylvania, several isolated plants supplying considerable districts and therefore necessarily running on central station lines, that is, with high tension alternating and series arc apparatus. There is, however, one isolated plant in the country which is even more nearly identical with the typical central station. It stands alone entirely removed from its loads, which are scattered and distant from it several miles in various different directions. Its distribution is over pole lines following the public streets, just as do the pole lines of any quasi-public central station. The plant referred to is the Frank Jones Electric Light Station of Portsmouth, N. H. Its load consists in the main of two large hotels—one a seaside summer resort—a brewery and the home and stock farm of the owner of all the property, whose name is incorporated in that of the plant. The station, while it is not new, has several very interesting peculiarities, which make a description of its general design and an account of its operation of interest, as does also the fact, well known throughout that part of New England, that nothing is too good for the Hon. Frank Jones.



THE THREE MAIN ENGINES.



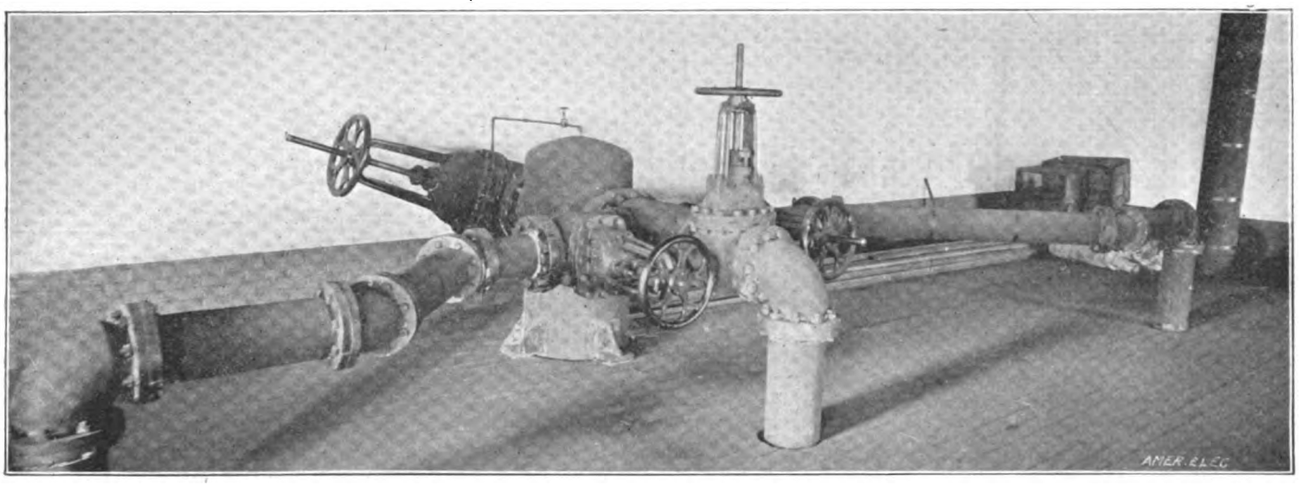
THE BOILER EQUIPMENT.

Structurally the generating plant consists of a brick building about 60x105 feet in size, as the plan on page 205 shows, standing beside the railroad track about one mile south of the center of the city. A spur runs in over the coal pocket, which has a capacity of 600 tons below the rails.

The boiler equipment consists of three Heine safety water-tube boilers, rated at 200 h.p. each, standing in a row, as the adjacent illustration shows. The products of combustion are taken by a brick flue resting on the top of the boilers to the steel stack, which is 6 feet in diameter and 150 feet high. This stack, a good view of which appears in the illustration of the station exterior, is encircled at its top with a crown of sixty-eight 16 c.p. incandescent lights. The powerful draft given by this stack, with its great size and height for the load it carries, is controlled by a Spencer automatic damper regulator.

The feed water comes to the station

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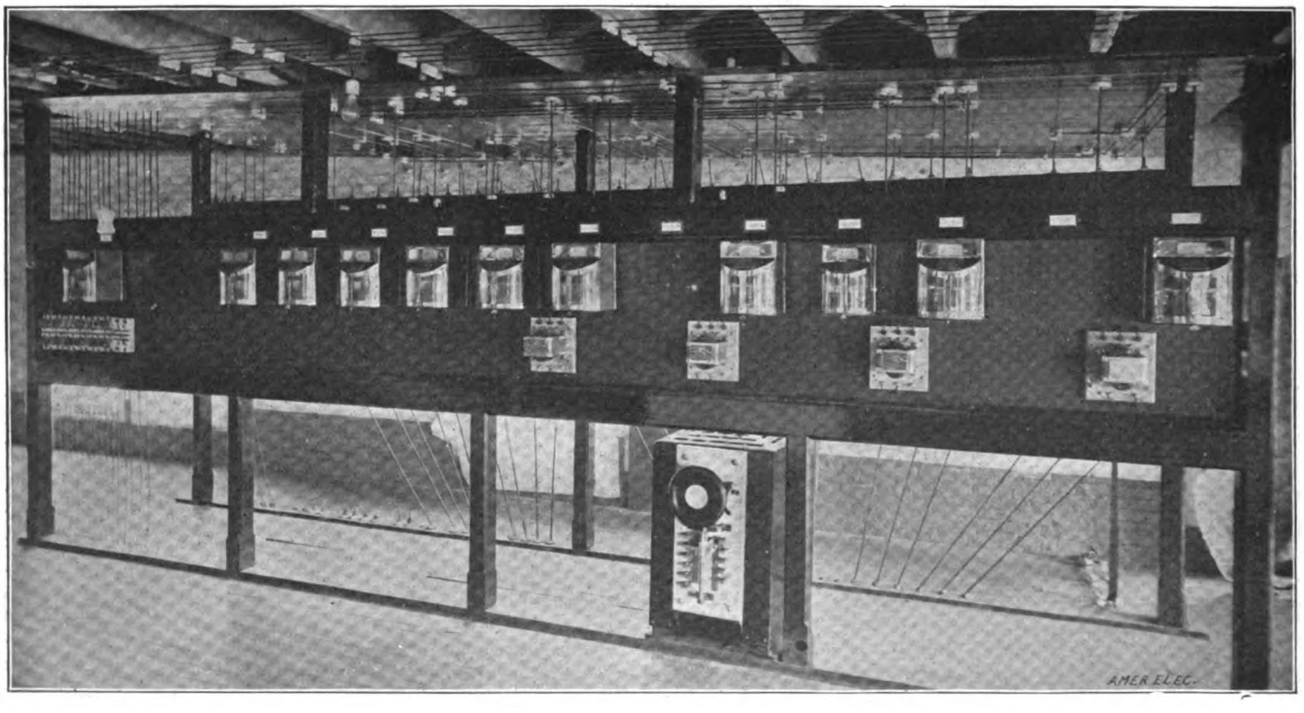
[illegible] ABOVE THE ENGINE ROOM CEILING, SHOWING SEPARATOR AND ARRANGEMENT OF VALVES.

from the Frank Jones pumping station, a complete water plant for private property resembling, as does the electric light plant, a public institution. The incoming feed water is passed through a Webster vacuum heater, where the engine exhaust heats the water up to within two or three degrees of the boiling point. The hot water is then taken by a Deane pump, placed well below the heater in order to give a solid body of water to prevent vaporization under pump suction, and is delivered to the feed line. All the feed water piping, as well as the water columns, is of brass. A Hancock inspirator gives a reserve means of feeding the boilers. All feed water is measured by passing it through a Crown water meter, which is calibrated once a month by weighing on scales the amount of water registering a certain number of cubic feet. The coal is also weighed in wheelbarrows on its way from the coal pocket to the boilers,



so that with the records of the integrating wattmeters a fairly accurate tally is obtained of the economy of the different parts of the system.

The main steam piping consists of a 10-inch header collecting the steam from the three boilers and a 10-inch main to the Stratton separator, which is located in the upper story over the engine room, the lower end of the separator coming down through the engine room ceiling. From the separator the steam goes to a cross, and from the three branches of this to the three engines, all horizontal runs being made above the engine room ceiling, so that the only piping in the engine room is the vertical drop of the steam pipes to the engines and of the exhaust pipes to the exhaust header under the floor below. A view of the arrangement of the separator, the cross and the valves in the attic above the engine room is shown at the head of this page.

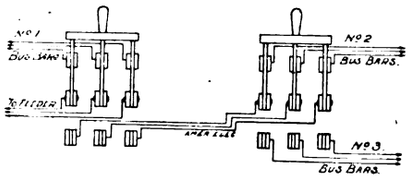


THE PRIMARY METER BOARD.

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The prime movers consist of two simple Ideal and one cross-compound Ide engines, all built by the Harrisburg Foundry & Machine Works, and to each of these there is belted one alternating current generator. The exhaust steam is taken over to the open heater above mentioned, which is simply tapped off from the exhaust riser through two grease extractors. The dynamos are all General Electric monocyclic, 60-cycle machines wound for 2,100 volts and fitted with rectifiers and composite fields. They are of different sizes, namely 50, 100 and 150 kw. ratings, to absorb the outputs respectively of the 100, 150 and 250 h.p. engines. Each dynamo has mounted on its terminal plate an Elden circuit breaker, in which, as is well known, both the field and armature circuits are broken when the breaker operates.

Besides these three generators, there is mounted in one corner of the station a pair of machines coupled together, one of them a 50-lamp T. H. arc dynamo and the other a 50 kw. 60-cycle monocyclic dynamo. These were originally put in as a motor generating set, the purpose being to run the monocyclic machine as a motor from one of the other generators, and from it drive the arc dynamo. It has been found preferable, however, to drive this coupled pair by a pulley surrounding the coupling and a belt run tandem with the other belt on the small engine. The motor dynamo set has no sliding rails, and the belt is tightened by an idler pressed upwardly against its under side. The exciter of this alternator is ingeniously mounted on a bracket on the wall and the bracket is worked up and down by a screw to tighten its belt. When the machine was used as a motor this exciter served to bring it up to synchronous speed.

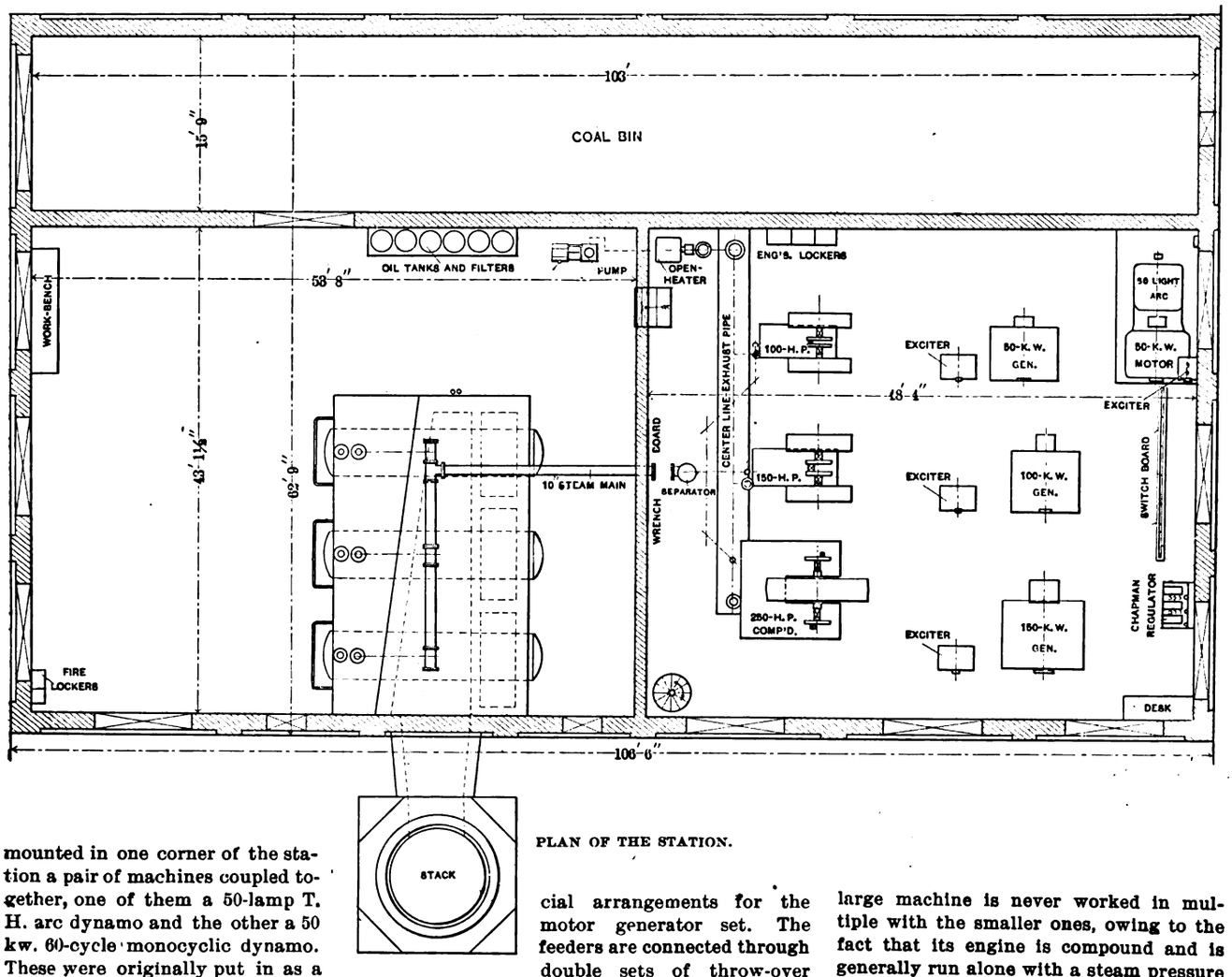



THE CONNECTIONS OF FEEDERS TO BUS BARS.

The switchboard is quite an elaborate affair, owing to the fact that arrangements are provided for running the machines either singly or in multiple, necessitating three sets of bus bars with special arrangements for the motor generator set. The feeders are connected through double sets of throw-over switches, so that they may be supplied from any one of the three sets of busses. The bus bars, main switches, fuses, etc., are all, of course, triple pole to provide for the two main and the one teaser terminals of the monocyclic machines. Just as in the multipling of compound wound direct current machines, there is necessary an equalizer connection to prevent unstable running due to the series field; this is provided on this switchboard by a double pole equalizer and equalizer switches which cross connect both ends of the series field windings of the machines to be run in parallel. The dynamos are regularly worked in multiple, and even when only changing over from one machine to another the fresh machine is synchronized and thrown in parallel with that already running, which is then taken out, thus transferring the load without the slightest interruption of the current delivered. The machines are synchronized with receptacles and plugs connected with phasing lamps in the usual way.

Each machine has its own set of three pole bus bars and the four outgoing feeders are fitted with double sets of double throw switches, by which they can be thrown to any one of the three sets of bus bars. Two of the latter may also be connected by bus junction switches. The large machine is never worked in multiple with the smaller ones, owing to the fact that its engine is compound and is generally run alone with a steam pressure of 125 pounds, 45 more than are carried by the same boilers when working the single cylinder engines.

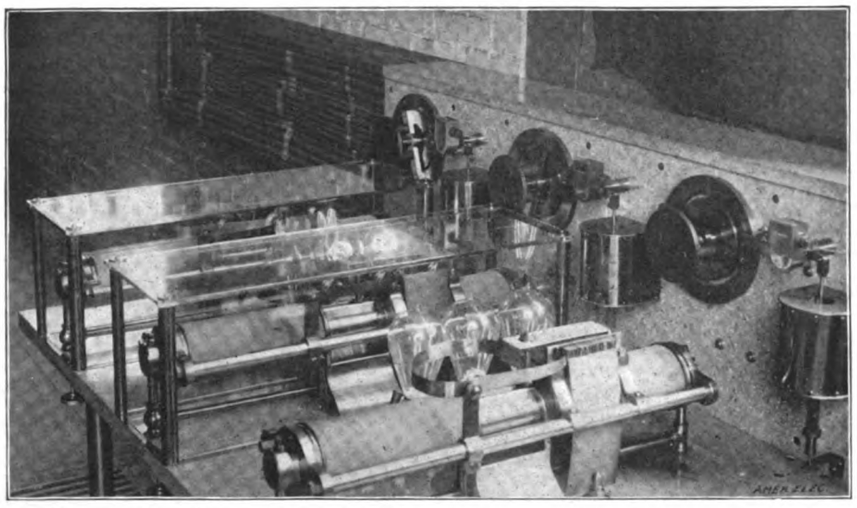
The voltage is indicated by a bracketed alternating current voltmeter supplied over pilot wires run back from a point on one set of the feeders about two-thirds of the way into the city, thus getting the major part of both the ohmic and inductive drop, the latter of which must be par-




PLAN OF THE STATION.

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ticularly watched, owing to the running of induction motors. On the same account the compounding ratio of the generators has been made adjustable by using for the shunt of the series field of each machine a Carpenter enamel rheostat mounted on the generator panels of the switchboard. The fields have an unusually heavy series coil, and during the summer, when the motor load is larger than at other times, the rheostats are turned to give a greater ratio of compounding than during the winter, when the load is less inductive. In order to obtain practically constant potential on the station lamps they are also fed from lines run back from taps on the main feeders about two-thirds of the way to one of the points of distribution.



THE AUTOMATIC VOLTAGE REGULATORS.

To further assure the maintainance of constant potential with all the precision obtainable in a plant of this size, Chapman automatic voltage regulators are used. The equipment of these instruments is worked out with unusual care and finish to make a most attractive and showy appearance. The three regulators are mounted on a low table of pink Tennessee marble and each is covered with a plate glass box. Each has the adjustable series or compounding coil by which they may be made to overcompound for the line drop. The combination of automatic voltage regulators with composite wound generators is something not often found, but the experience obtained in this station shows it to be a successful one. When running in parallel, separate regulators, one for each machine, are not connected up, as they would, on account of the overcompounding feature, tend to seesaw the load from machine to machine, unless fitted with some device which would act as the equivalent of an equalizer. One voltage regulator is worked on one of the machines in parallel; its operation affecting the voltage of both, owing to the way in which alternators mutually adjust each other to the same voltage when running in parallel.

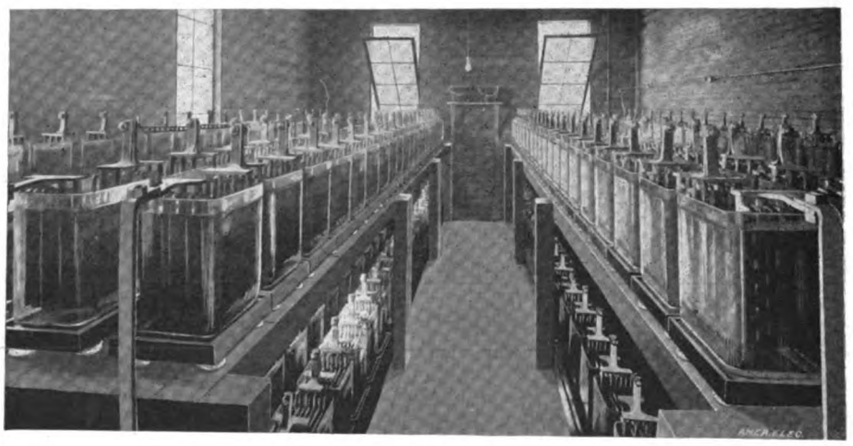
The loads of this isolated plant or central station, whichever one pleases to call it, differ from those of the average central station in that they are concentrated in several small areas, whereby they may be supplied through a few large and efficient transformers instead of a lot of small house to house transformers. There are four loads, as mentioned above, each supplied by its own feeder, the largest of these being the mammoth summer hotel, the Wentworth, which has between six and seven thousand lamps wired up on the three-wire system in part, and with its own distributing switchboard fed by a bank of a few large transformers. The hotel has also its own potential regulator or induction booster, so that the voltage can be controlled by any one at the hotel itself, a wise provision, as the distance from the power house station is almost three miles. Another potential regulator at the generating station is used for separately controlling one of the other feeders, the remaining two depending on the composite winding and the compounded automatic voltage regulators.

Upstairs above the engine room there is a special meter board made of slate and carrying Thomson integrating water meters in glass cases, one in each of the outgoing feeders and one in each of the teasers on the circuits which carry motors as well as lights. The indications of these meters are carefully compared with those of the secondary meters on the other side of the transformers on the same lines, and the two record within three or four per cent. of each other, showing that the losses in both the high tension distributing lines and the transformers come within this small figure. Such high efficiency is, of course, possible owing to the concentration of the loads and the use of large transformers. A view of this meter board appears on page 204 and shows also the way in which the vertical wires from the switchboard below are kept taut by means of bolts and nuts in porcelain bushings. The load curves of this plant of course differ considerably from those of the average central station, the heaviest loads being in the summer and then only for a very brief interval of an hour to an hour and one-half during the evening. During the month of August last the total number of kilowatt hours recorded was 17,140, which cost 3.85c. per kw. hour, including labor and the rather low depreciation of two per cent. on the station, a very fair figure considering the low load factor. The coal burned during the same month was 92 tons, 300 pounds.

The chief engineer of the station is Mr. A. M. Barton, to whom thanks are due for the information given above.

## Electric Railway Power Plant Driven by Gas Engines.

For fluctuating loads small electric roads are so notorious that they have become a by-word among many engineers, who, when they wish to express the idea of extremely annoying current variations, compare them with the load of a two-car railway. One of the chief arguments against the use of the gas engine has been its inability to regulate well or even work at all with extreme load changes, so that the operation of such a road by gas engines indicates a distinct advance in gas



THE STORAGE BATTERY ROOM OF THE HUNTINGTON RAILROAD PLANT.

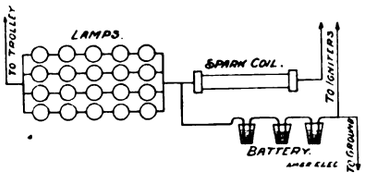
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engine design and electrical engineering.

The Long Island Railroad Company has a network of trunk lines ramifying over the island from which it takes its name, but these lines unfortunately do not, as a rule, run closely along the shores where the popoulation tends to concentrate. Particularly is this the case with the Port Jefferson branch, which runs along a section of the Sound shore on the northern side of the island. The road follows an elevated tableland from one to three miles back from the shore, according to the indentations of the latter, the nearest point to the village of Huntington being about two miles from the town center.

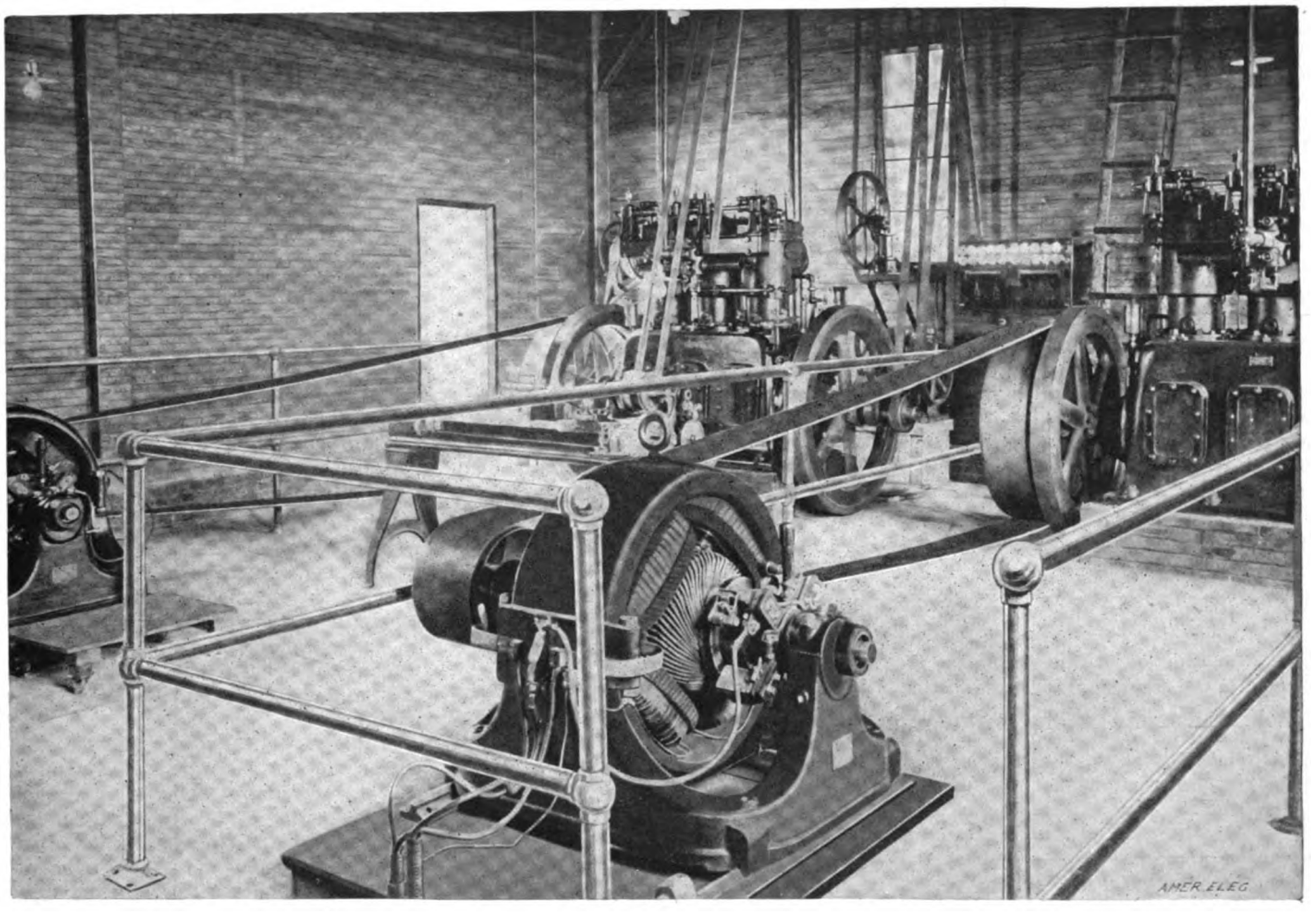
Following a policy which it intends to adopt throughout its whole system, the railroad company has bought up the franchise of the local horse railway and equipped the line with an electrical system for the purpose of working it as a feeder to its main line. The road is single-tracked, about three miles in length, runing down from the station to the village and thence to the shore in a neighborhood occupied by the handsome country seats of wealthy New Yorkers. At the shore end is the power plant, while at the other end the line climbs 165 feet up to the plateau of the steam railroad with grades running up to 4½ per cent. The load curves on such a system can be easily imagined. Running with one car, as it often does, a comparatively heavy current is demanded while the car is climbing the grade, the loads at all other times being small or nothing.

The power house equipment consists of




THE IGNITER CIRCUITS.

two Westinghouse, 3-cylinder, vertical gas engines, each of 50 nominal b.h.p., taking their gas supply from the adjacent works of the local gas company. These engines have the standard features of Westinghouse design, notably the regulation by varying the charge of the fuel per stroke, instead of the hit or miss method of governing, this feature making them particularly well suited for traction work. The only details about them departing from customary practice are the arrangements of the igniting circuits. Current for the electric igniters is taken from the 500 volt railway generators and passed through 20 incandescent lamps, connected in four groups of five lamps each in series, as indicated in the accompanying sketch of connections. From these lamps it goes to the spark coil and thence to the igniters. The high voltage, however, tends to make the spark persist across the igniter contacts and hold a small arc, which, of course, immediately causes "back fire" in the mixing chambers as soon as the admission ports are opened. To overcome this there is shunted around the spark coil and igniters a set of what might be called storage batteries, consisting simply of three ordinary glass tumblers with lead strips bent over and dipping into the ordinary sulphuric acid solution in them as the sketch shows. These take the current when the igniter circuits are open, reducing the voltage across the igniters to about seven volts, and absorb a charge at such times, which is given out again to the igniters as soon as their circuits are closed. The igniters are supplied by a battery of 12 Edison-Lalande primary cells when the engines are starting.




THE DYNAMOS AND GAS ENGINES OF THE HUNTINGTON PLANT.

Each engine is belted to a 37½ k.w. Westinghouse, 4 pole, 550 volt generator. In a neighboring room is a storage battery of 265 cells of chloride accumulators, having a maximum discharge rate for short periods of 44 amperes. These are worked without booster or end cell switch, directly in multiple with the dynamo or dynamos, the latter being fitted with special compound windings, by means of which their voltage is made to fall off as the load rises to such an extent that the battery will take the greater part of the load fluctuations.

The road has been running since June

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20, 1898, with one car during the winter time and three open cars during the summer season, having carried over 5,000 passengers in a single day. The ordinary car mileage is about 200 miles per day, the gas consumed amounting, it is stated, to about 46 cubic feet per car mile; the total operating expenses, with gas at 90 cents per 1,000 cubic feet, and including motormen's and conductors' wages, being about 13 cents per car mile.

The road is now in charge of Chas. F. Wingate, Superintendent, and Frank Tryon, Jr., Engineer.

## A SIMPLE STEAM ENGINE WITH A REMARKABLE STEAM ECONOMY

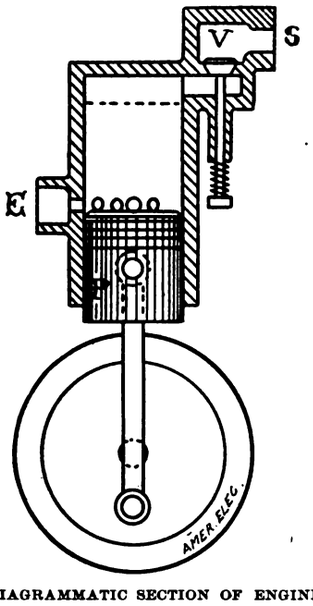
There has appeared in the verbal and communicated discussions of the American Institute of Electrical Engineers a description of a small and simple steam engine which has given most surprising results in steam used per h.p. hour. The engine is one developed by Prof. Elihu Thomson for steam automobile work and closely resembles one recently designed in France for the same purpose by M. Serpollet. It has four cylinders each 2½ ins. in diameter and 3 ins. stroke, all single acting and worked single expansion, thus being virtually four small engines, each of a little over 1 h.p. capacity, the output of the whole being about 5 h.p.

The economy obtained with this small machine reached the surprising figure of 20½ lbs. of water per h.p. hour, the output being measured by a dynamo driven by the engine; the amount of water per indicated h.p. being undoubtedly less than 20 lbs. The steam pressure carried was between 160 and 200 lbs., but there was a considerable and variable degree of superheating, the engine being worked at times with the steam pipe red hot.

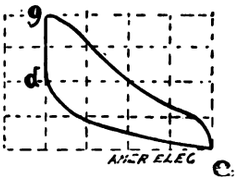
The departures from ordinary designs in the construction of this engine are indicated in the accompanying cross section and consist mainly in the arrangement of the valves, the exhaust port consisting of a number of holes, E, arranged in a ring in such a position that they are uncovered by the piston, B, at the extreme outward position of its stroke. In order to use a high degree of superheat the steam is admitted by a simple poppet valve, V. The clearance is large, giving a cycle much like that of a gas engine with the idle revolution removed. A puff or explosion of steam, as it might be called, is admitted by a very brief opening of the poppet valve and this expands until the piston uncovers the exhaust ports. The exhaust line is not horizontal as in the ordinary steam engine, but from the time that the exhaust ports are re-covered by the piston the compression is continuous and adiabatic until the piston arrives at the inner end of the stroke and a new charge of steam is admitted. A typical indicator card is shown in the accompanying cut. Some of Prof. Thomson's comments upon the engine are as follows:

"The conditions are such that there is no re-traversing of passages, no re-traversing of even the cylinder portion. The steam enters, goes forward and out, and it is running steadily forward, so that we do not have any of those inter-actions that use up energy. We have a temperature gradient from one end to the other of steam cylinder.

"The engine was in good condition, of course, but not exceptionally so. Its simple construction permits of relatively easy maintenance. When I made the engine I expected to realize a result of about 30 pounds of dry steam per brake h.p. hour, which in itself would have been roughly about twice as economical a result as is shown in the best tests of such very small engines, of which I was able to obtain any data. I was skeptical of the result of the first tests, and freely expressed my doubts, but by going over the work and watching it personally, while insisting that everything be done to have the errors count against the engine rather than in favor of it, I became convinced that my expectations had been greatly exceeded, and that a result of 20 pounds per h.p. hour, or slightly better than that, had been, in fact, obtained, as I have indicated.




DIAGRAMMATIC SECTION OF ENGINE.




CARD SHOWING ZERO CUT-OFF AND 100 PER CENT. COMPRESSION.

"It remains to finish and test an engine of larger capacity and to do it under such varied conditions as will be likely to point out the relative values of those features which undoubtedly contribute to the still lower consumption which will probably be obtained.

"The small engine tested was designed for automobile work, it being regarded as extremely desirable that but little water and fuel be carried, and but little steam escape during work. The clearance is great and the manner of exhaust and admission such that no trouble is ever experienced with condensed water in starting.

"The engine is now in use upon a steam automobile, having a coil-pipe boiler heated by ordinary kerosene. It runs satisfactorily even under the very extreme condition, adopted in some experiments with it, of a steam supply pipe at a bright red heat. But this is, of course, abnormal and only indicates the wide range in character of steam which is permissible. That it is not injured by excessive heat in the steam suppled is due, doubtless, to the poppet valve admission, and the extremely early cut-off which permits the entrance of only a momentary puff of hot steam when the piston is full in."

## THE CANDLE POWER OF ARC AND INCANDESCENT LAMPS.

### THE AMYL ACETATE LAMP.

BY PROF. WILBUR M. STINE.

The failure of candles as standards of light strength was found to be caused by the uncertain composition of the combustible and by the charring and alteration of the wick, and certain mechanical effects of the heat generated by the candle flame. Again, the failure of the Methven screen was due to the complex nature of illuminating gas and the impossibility of reproducing any given quality of gas, and the further objectionable feature of a gas chimney. The pentane flame is being abandoned as a light standard from much the same causes; sufficiently pure pentane can not be obtained commercially, and especially the heating effect of the flame on that part of the wick-tube in which the pentane vaporizes, this in itself causing the flame to alter in its illuminating power.

In this survey it appears that the principle sources of variation in the standard of light are due to the complex and uncertain quality of the combustible, and to the wick or the arrangement for vaporizing the combustible. An improved standard, then, must be free from these objectionable features. Up to the present time the most successful improvement over the former light standards is one of German origin designed by Hefner-Alteneck and announced by him early in 1884. This new standard was developed in the course of a lengthy investigation of the previously existing standards of illuminating power. Hefner's first care was to find a suitable combustible, chemically simple, and one that should vaporize readily and avoid the charring of the wick. His final selection was amyl acetate, which he burned in a specially modified spirit-lamp. As now used this lamp is essentially as he first designed it, but with a few refinements and modifications which increase its accuracy.

Description of the Hefner Lamp.—The standard form of the Hefner lamp is

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shown in vertical section in Fig. 1. The pair of toothed wheels actuated by a worm gear are for adjusting the height of the wick in the tube C. When in use the cap D is unscrewed and removed. The wick-tube C is made in German silver and must accurately conform to certain prescribed dimensions. Moving concentrically with the wick-tube is a plate H, which carries a pillar topped with the Kruss optical flame gauge shown in elevation in Fig. 2. The essentials of the flame gauge are a magnifying lens and a screen of ground glass fastened in the eye piece. The glass screen has a diametrically horizontal scratch made on it, accurately cutting the optical axis of the gauge. As further indicated in the figure, the distance from the top of the wick-tube to the optical axis of the gauge is 40 millimeters. This length must be adjusted with the greatest possible precision and the adjustment is tested by the use of a gauge shown in Fig. 3. This test gauge is placed over the wick-tube, and when the top of the wick-tube is viewed horizontally through the slits there should be merely the very slightest observable clearance if the wick-tube is of the proper height. The top of the gauge is ground off to a slight bevel, giving a truly horizontal edge. This edge, viewed through the optical flame gauge, must sharply coincide with the scratch on the glass screen. This most ingenious arrangement of gauges enables the operator to test the accuracy of this most essential dimension of 40 millimeters. The function of the optical flame gauge is to indicate the adjustment of the flame to the standard height.

The Combustible.—Amyl acetate is a colorless and very mobile liquid which

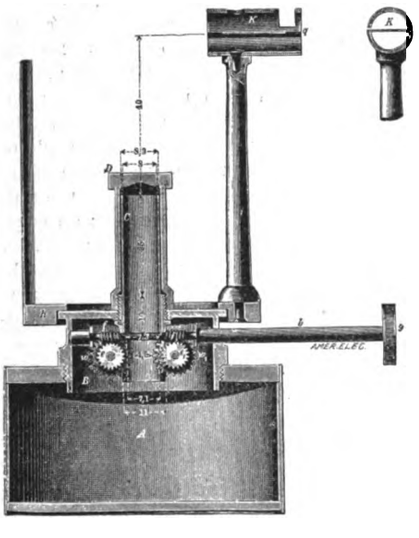


FIG. 1.

vaporizes rapidly on exposure to the air. It has a pungent but pleasant fruity odor. Chemically, it may be regarded as derived from the combination of amylic alcohol and acetic acid. Having the chemical formula, $C_5H_{11}C_2H_3O_2$ it contains only carbon and hydrogen as oxidizable constituents, and in this respect leaves little to be desired.

Amyl acetate is prepared commercially by the distillation of amylic alcohol obtained from fusel oil, with a mixture of acetic and sulphuric acids, or by distilling a mixture of ethyl or ordinary alcohol with sulphuric acid and potassium acetate. It has recently come into extensive use in the arts. It is an excellent and rapid solvent for shellac and similar resins and celluloid. Not a few brands of armature or insulating varnish are made up with this solvent, as is readily apparent from their peculiar odor. Similarly a widely used make of metallic lacquers contains celluloid dissolved in amyl acetate. Being so extensively used, many cheap grades of this chemical are on the market, having a more or less yellow color. Under no circumstances is this quality of amyl acetate suitable for photometric purposes.

The Purity of the Amyl Acetate.—For the photometric purpose of burning in the Hefner lamp, only chemically pure amyl acetate should be employed. At present this is somewhat difficult to obtain in this country, but doubtless the difficulty will be obviated upon the increased use of the lamp when the chemical supply



FIG. 3.

houses shall have learned the requirements for the purity of amyl acetate for a light standard. In Germany the investigations of the Hefner lamp have been so thorough and general that amyl acetate of the requisite purity can be readily imported thence.

The German Gas Commission has prescribed certain tests that may be applied by any one in order to be assured that the amyl acetate burned in the lamp is satisfactory. The prescribed tests are:

(1.) The specific gravity at 15° cent. shall be from 0.872 to 0.876.

(2.) When distilled in a glass retort at least 90% shall pass over between the temperature limits of 137° and 143° Cent.

(3.) The reaction should be practically neutral and blue litmus paper not sensibly reddened by it.

(4.) It should mix with an equal bulk of either benzine or carbon disulphide without becoming milky.

(5.) A clear solution should result upon shaking in a test tube 1 c. c. of amyl acetate with 10 c. c. ordinary alcohol of 90% strength and 10 c. c. of water.

(6.) A drop placed on white blotting paper should evaporate without leaving a greasy spot.

These tests, though readily applied in a chemical laboratory, are yet too complicated for general practice. Should the use of the Hefner lamp become general in this country as it has in Germany, it would necessitate that tested amyl acetate could be obtained from a reliable and au-

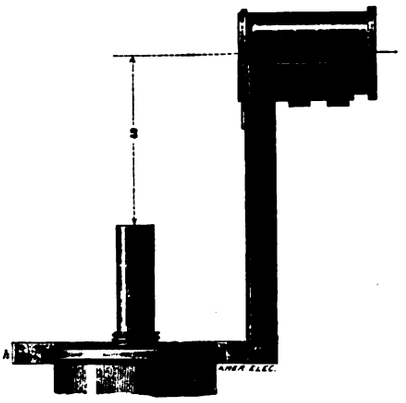


FIG. 2.

thoritative source. In Germany the National Physical Institute (an institution of a character to be urgently needed in this country) and the Gas Association undertake this authoritative supply.

The Wick.—The fact that this light standard operates with a wick does not necessarily imply that the wick introduces a factor of uncertainty in the light value. In the case of the candle it does to a marked degree, because the vaporization temperature of the combustible is higher than the temperature at which cotton chars. In contrast, amyl acetate vaporizes at a comparatively low temperature, so low in fact that cotton does not perceptibly char under its influence. In the candle the wick chars and is really a part of the combustible feeding the flame; in the Hefner lamp it does not char but simply acts as a supply tube by capillary action to keep the end of the wick moistened. The only requirements for the wick are—that it shall be perfectly clean and entirely fill the wick-tube, and not be compressed too tightly, but cause a sufficiently rapid flow of amyl acetate to maintain the end of the wick in a moist condition, or, what amounts to the same thing, that it shall supply the amyl acetate as rapidly as it is consumed. For mechanical reasons, so the wick shall not catch in the teeth of the adjusting wheels, it should be woven preferably than twisted.

The Color of the Flame.—The amyl acetate flame has a decidedly red tinge, and this is one of the most objectionable features of this light standard. It is impossible to compare the illuminating power of lights which especially differ in color. Even the candle flame is whiter than the flame from amyl acetate. The color contrast is especially marked with white incandescent light and bluish arc light. The unfortunate color of the flame of this

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lamp, probably more than any other feature, has prevented its general international adoption.

The Flame Height.—As already indicated, the prescribed height of the flame above the edge of the wick tube is 40 millimeters. This particular height was selected after elaborate tests had shown that it corresponded to the most constant behavior of the flame. The rate at which the illuminating power of the flame increases for each increment in height above 40 millimeters is 2.5% per millimeter, or 1 per cent. for each 1/64th of an inch. For each millimeter less than 40 millimeters the decrement in illuminating power is 3%. Though at first glance it might seem to be a grave objection to this particular light standard that its illuminating power changes so greatly for slight alterations in flame height, in practice the magnifying optical gauge is found to be so sensitive in its indications that one may maintain the flame practically at the required height with ease, and the errors due to such causes in the hands of a skilled operator are sensibly negligible.

Reproducibility.—In this respect the Hefner lamp may be safely asserted to excel all other light standards. The combustible is chemically simple and definite, and the wick is without influence on the light value so long as it is clean and not compressed to such an extent that it fails to keep the end of the wick constantly moistened. The essential mechanical details require excellent workmanship, but as the proper dimensions are so accurately known, the structural requirements can be met.

The Influence of Humidity.—We now come to the discussion of certain influences which may introduce very large errors in the estimation of the illuminating value of a flame. All flames in their illuminating powers—candle, gas, pentane or amyl acetate—are very sensitive towards atmospheric humidity, though not all to the same extent. Liebenthal, a most reliable investigator, has determined the value of the effect of the atmospheric humidity on the illuminating power of the amyl acetate flame. He measured the light strength of the flame at frequent and regular intervals for a period of two years. The greatest variation of light strength which he found in these tests was 8.5%. This possible error in photometric measurements is so great that it may well throw doubt on all comparisons of light strength in which no correction has been made for atmospheric humidity. The general technical reader has no doubt been often confused, and, to a certain extent, disgusted with the great discrepancies in published photometric data, and possibly has come to the conclusion—and who shall say that it is entirely a mistaken one—that photometry is not a scientific branch of measurement. At some time or other probably each incandescent lamp factory has sent special lamps to colleges and technical laboratories to be rated. Upon their return they have generally been found to disagree more or less widely. The photometrist in all such cases has been roundly censured. Especially since the publication of Liebenthal's data in 1895 a certain part of the discrepancies may be avoided. With all this knowledge in possession it can be stated with considerable assurance that no ultimate measurement of illuminating power based on either the amyl acetate or pentane lights should be accepted which are not explicitly accompanied with the amount of the humidity at the time of measurement, and whose values are not corrected for the particular humidity.

Conforming to the ruling of the German Physical Institute, now generally accepted, the amyl acetate lamp gives normal illuminating power when the humidity of the air amounts to 8.8 liters to the cubic meter of dry air. If h denotes tne humidity in liters of moisture to the cubic meter of dry air and I denotes the corresponding illuminating power of the flame, the correction is made by the equation:

$$I = 1.049 - 0.0055h.$$

All measurements of illuminating power purporting to be authoritative should now be accompanied with this equation and the data for correction. It may be interesting to add that Liebenthal used the Assman hygrometer to measure the humidity.

The Influence of Atmospheric Pressure.—As pointed out in the first paper in this serial, the illuminating power of a flame decreases as the atmospheric pressure lessens. In the particular case of the amyl acetate flame the variation is small and for a change in pressure from 30 to 29 inches it only amounts to nearly one-quarter of one per cent.

The Influence of Carbon Dioxide.—This gas, when present in the air in appreciable quantity, acts like humidity to decrease the illuminating power of the flame. However, for the usual range of carbon dioxide content of the atmosphere the influence of this gas on the illuminating power of the amyl acetate flame does not exceed one-quarter of one per cent. and is negligible in effect.

A precaution must be added: In case the lamp is used in a small room, unless the ventilation is excellent, the carbon dioxide from the breath of the operators and the flame under test may become so great in amount that it will introduce a sensible error.

The Adoption of the Hefner Lamp.—At the Niagara meeting of the National Electric Light Association a report was adopted containing as one specification, "The Hefner-Alteneck amyl acetate lamp is recommended as the primary standard, it being, on the whole, the most reliable and uniform. It possesses the additional advantages of having been subjected to most exhaustive tests to determine its behavior under different conditions, and of being readily obtainable in standard form from authoritative sources."(1)

Also on January 19, 1897, the American Institute of Electrical Engineers adopted a provisional report to the effect that "The Hefner-Alteneck amyl acetate lamp furnished with test certificates from the Physikalisch-Technische Reichsanstalt (German Physical Institute) at Charlottenburg, Berlin, should be temporarily adopted as a concrete standard of luminous intensity, or candle power."(2)

(1) Electrical Engineer, June 16, 1897, p. 676.

## ECONOMY OF MULTIPLE EXPANSION ENGINES.

BY WM. S. ALDRICH.

It has been quite the fashion recently to place all the blame for waste in the production of electric power upon the supposed uneconomical working of multiple expansion engines with rapidly fluctuating loads. By this type of engine is meant that in which the number of expansions is carried out in more than one cylinder—in two, three or four cylinders, as the case may be—by compound, triple or quadruple expansive working of the steam. The expansion of the steam is carried on either intermittently, as in engines with receivers between the cylinders, or continuously in the tandem and other arrangements of the non-receiver or "Woolf" type of multi-expansion engine.

Primarily, the variation in economy due to the variable number of expansions incident to the load changes is responsible for almost all of the odium which has attached to multi-expansion engines for electric supply service. At the outset it is presumed that in any given plant the engines would be worked under conditions favorable to the greatest economy if the loads were not so variable. That is, at least in the case of the larger generating units that are designed for the use of high pressures and preferably superheated with high ratios of expansion and operated condensing. The principles underlying the treatment of this topic do not touch the question of the value of the condensing system, dealing as they do with more or less known effects on economy due to variations in the expansive working of steam, rather than with the small unknown quantities pertaining to the efficiency of condensing under varying loads.

The transient or instantaneous changes in load of electric railway service are here considered in their effects on economy as compared to the more or less permanent changes of load in lighting service. The distributive and the disconnective systems of installation of steam motive powers are treated with special reference to electric light supply. The influence upon economical working of the method adopted for speed regulation, whether by throttling governor or cutoff mechanism, is discussed with particular reference to the wide range of variations in railway service.

The influence of the accessories of a

(2) Proceedings A. I. E. E., 1897, p. 90.

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steam power plant upon the economy under variable loads is touched upon merely, not being of such commanding importance as the manner of working the steam in the multiple expansion units. The changes due the latter are productive of marked effects upon economy under variable loads, whether the expansions are carried out in one or more cylinders, but especially in the latter case. The use of superheated steam, the effect of cylinder condensation, the quality of the steam throughout its working, and the condition of the cylinder walls of the last or low-pressure cylinder at the point of release, all influence the economy under variable loads. It is a question how best to meet the exigencies that arise in each stage of the expansive working that the best results may be obtained under wide variations of initial and intermediate conditions, but with fixed terminal conditions. The variations in economy of multi-expansion engines are clearly due to the variable manner in which steam is necessarily worked from early to late cutoff in the several cylinders. It is also, in some types, a question of the best way to secure an economical continuous expansive use of the steam; and this has been considered in its relation to the non-receiver type of multi-expansion engines. Economy of installation and operation—the economy of the plant, the maximum kilowatt hours per pounds of steam supplied is really the question that mostly concerns stockholders and managers, and is therefore the true measure of value in comparing the economical performance of various installations.

In the electrical service there are two distinct conditions to be met, supply for lighting and supply for railway work. In the former the load is quite uniform for a greater or less period and is not subject to the sudden and wide fluctuations incident to the latter service. This has made it possible to meet the demand for greater economy in electric light supply by one or the other of two representative systems in the arrangement and management of the steam plant; namely, the distributive and the disconnective systems.

In the distributive system of arranging the steam power for lighting plants the subdivision of such powers into convenient and usually duplicate units is carried out. This is on the principle now fully recognized as applicable to all types of engines, namely, that they have a certain economical range of load beyond which it may be necessary, though not desirable, to operate them. For large blocks of load permanently thrown on or off the station, other generating units are thrown into or out of service to meet such demands as they arise under any given set of conditions. While this is evidently more necessary for simple as well as non-condensing compound engines with somewhat limited range of economical load, it is none the less important in handling the usual compound and other multiple expansion engine units when operated condensing.

This principle is right both in theory and practice. It recognizes the clearly defined limits for the economical working of the engine as a unit. It is convenient of application, the engineer usually having two or more such duplicate units slowly turning under light steam, ready to be thrown in at about the time of the day when such increased loads are expected on the lighting circuits. It reduces the expense of operation, losses due to friction, and the wear and tear of motive-power machinery. It enables the whole plant to be operated for electric light supply at a nearly uniform rate of steam consumption per kilowatt-hour of output. A lighting station so arranged will be able to maintain a high load factor. It is more economical to meet an increase of load of from 500 to 1000 kilowatts, by throwing into service another 500-kilowatt engine-dynamo unit than to attempt to supply both loads from a single 1000 kilowatt unit. The extent to which such subdivision may be carried is of course governed by the probable character of the lighting service to be supplied. At first, two or three duplicate units will probably give sufficient range, to which may be added other similar units to meet the demands of expanding business.

In the disconnective system of steam motive power for lighting stations a large triple or quadruple expansion engine is installed, so designed and constructed that one or more cylinders may be disconnected or thrown out of gear to suit the load requirements for a few hours and insure a more economical working of the cylinders remaining in service. Such unshackling of two or more connecting rods with other changes, takes but a small amount of time, it is true, but has not been found altogether meritorious. It may cause delay at a somewhat critical moment. It is a system that has been tried and found wanting at a critical time in the late war on the armored cruisers "New York" and "Brooklyn." While the central station manager is usually able to provide for such an exigency, the same idea was entertained regarding the cruisers on the blockade off Santiago, namely, that to insure the greatest economy, one or more of the cylinders of the multiple expansion engines should be disconnected during ordinary duty, fully expecting that when the time for the extraordinary should arrive all of the cylinders and their gear could be connected up in short order. In general, it may be said that a duplicate unit may be thrown into service with greater readiness and far more certainty of meeting the increased demand than by throwing into gear the parts of a disconnected multiple expansion engine. On the other hand, the disconnected system invites engine builders to argue the advantages of large multiple expansion engines for first installment, to be afterwards loaded up as the work of business expansion goes on. It is a question of providing for the future in the first installation or of providing similarly for increased business by installing duplicate units when the occasion arises.

In the case of the disconnective system it is apparent that changes at the engine itself are not the only ones called for, if any attempt is made to observe the underlying principles of the economical working of steam. To change from two to three cylinders, from compound to triple working, should be met by corresponding changes in the boiler pressure, dictated by the considerations of maximum economy. The same may be said of the change from three to four cylinders, from triple to quadruple expansion. Such increased boiler pressure, it is true, may be provided for in one and the same boiler plant; but it has been found by experience better to provide separate high-pressure boilers for the requirements of the higher ratios of expansion in triple and quadruple working. Otherwise, high-pressure boilers have been installed and kept in service throughout and the pressure reduced through the use of reducing valves. These latter have been so designed and operated as to conduce to greater economy with the smaller number of expansions through the slight superheating of the steam as it is reduced in pressure.

The problem of speed regulation of engines in electric supply service is far more important in lighting than in railway work. It is also a more difficult problem in multi-expansion engines than in single or two-cylinder units operated usually by one or two valves. Furthermore, the question of throttling compared with cutoff regulation will still be open until exhaustive experiments are made with both systems and with representative engines of simple and multiple expansion types under widest fluctuations in load. Until such a time, there are equally good reasons for throttling as for cutoff regulation, in order to maintain uniform speed under change of load in the case of simple or multiple expansion engines fitted with valves of the common slide or piston type. The four-valve type of engine, whether of the Corliss or later design, occupies a field so distinctively its own and is operated within such limited range of speed that it is not likely to enter the field of the smaller high-speed direct-connected units, whether these latter be simple or multiple expansion.

Regulation by throttling the initial pressure, in engines operated under a fixed cutoff, certainly has inherent advantages at light loads. The greatly reduced steam pressure through a properly designed throttle valve will be accompanied with the slight superheating that is so desirable at light loads. It is hardly probable that the undesirable extreme will be reached in throttling regulation; that is, the case of the initial pressure being so low that the expansion is carried below the back pressure or atmospheric line, in the case of non-condensing engines. In high-speed direct-connected multi-expansion engines, upwards of 300 horse-power or more, the English practice is remarkable as presenting well-authenticated experiments which would

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show that throttling regulations under these conditions is quite as economical as cutoff regulation, in the consumption of steam per indicated h. p. hour. In throttling regulation there are not the disadvantages due to high initial pressure at all loads with consequent variations in steam losses by leakage, by excessive frictional loss due to compression and the increased losses due to cylinder condensation, as in the case of cutoff regulation. Moreover, the resulting efficiency in either case, when determined by reference to the work done and not merely by reference to the indicated h. p. —to the pounds of steam consumed per kilowatt-hour output at the switchboard, is found to be considerably in favor of the throttling system.

The frictional losses and liability to derangement of complicated cutoff mechanisms in these high-speed multi-expansion engines are additional points to be considered in such an installation. The equal liability to be thrown out of adjustment by wear or careless and ignorant setting will lead to uneconomical steam distribution in cutoff mechanism that is not at all likely to occur in throttling regulation. With these types of engines throttling regulation may be brought within quite as narrow a range and by refinements of design and construction will be found to give as close regulation as the cutoff mechanism. The effect of fly-wheel inertia is important in either case and, if not supplied by the heavy armatures of the generators, must be otherwise provided for. The value of this is so important in speed regulation that it is of itself sufficient to more than offset the disadvantages of one system compared with the other, if introduced to such an extent as to make it a controlling factor in comparing the regulation by throttling to that of cutoff mechanism.

Regulation of speed by variable cutoff is the controlling feature of almost all types of engines in this country. In the older engines of the compound and triple expansion type such regulation was obtained by a variable cutoff on the high pressure cylinder alone. It proved entirely satisfactory for steady loads or those only slightly variable, as in the case of mill engines, and in electric light service. Such method, however, proved very unsatisfactory, both from the standpoint of close regulation and of good economy, when electric railway service came into vogue with its sudden and wide fluctuations in loads. It is possible to obtain quite close regulation in large multiple expansion units and without detriment to economical working even in railway service.

Simultaneous control of the cutoff valves on each cylinder of a multiple expansion engine has been found practicable and satisfactory. In this manner the distribution of steam in each cylinder may be made more or less proportioned to its size and to its share of the total load. Under certain conditions of such service it may be necessary to sacrifice, for a moment, economy to regulation. This is apt to occur in the case of the receiver types of multiple expansion engines at moments of extremely light loads due to early cutoff in each of the cylinders. The back pressure is increased in the receivers acting as a brake upon the engine, and likely to give an aggravated case of negative power by forming a looped indicator diagram. This may be provided for, however, by allowing considerable "drop," as it is called, in the receiver, which drop in pressure will be greatest under heavy loads and least under light loads. Of course, with a fixed back pressure such looped indicator cards and consequent negative power are equally detrimental to good economy.

In a future number the influence of various accessories upon the economy of the different type of engines will be discussed.

## EFFICIENCY OF SMALL MOTORS.

BY ALTON D. ADAMS.

Owing to the extended and extending use of small electric motors of from ½ to 10 h.p. capacity, the greater part of power distribution being in these units, much importance attaches to efficiency in such machines.

The word efficiency is frequently used in various senses, but is intended here to express the ratio of mechanical power given off by the motor, divided by electrical power entering at the brushes.

Efficiency, as here used, means the above ratio when the motor is doing full rated work, unless stated to apply at some definite fraction of load.

Various features of motor construction are sometimes stated as direct factors in motor efficiency, which are at most but secondary in their effect, or may have their influence entirely offset by other features.

For example, efficiency is said to depend on the shape of teeth or area of armature core, extent of pole pieces, length of air gaps, area of magnet core, number of turns in armature winding, and the length or depth of magnet coils.

The facts are that any one of these features may be varied within wide limits without material effect on efficiency, provided other parts are made to correspond.

Thus electric motors of various makes, having about the same efficiency, vary, for the same capacity and voltage, by more than 50 per cent in magnet core areas, 60 per cent in armature turns, 100 per cent in length of air gap and more than 100 per cent in depth of magnet winding.

A more definite idea of the character and location of the several losses in motors will enable purchasers to very nearly determine the efficiency in any case by very simple means.

All energy lost in electric motors usually comes under the three following heads:

1. Loss in armature and magnet windings.

2. Losses in iron cores and poles.

3. Losses by friction of bearings, commutator and air.

The losses in armature and magnet windings are easily calculated when the resistance of each in ohms, also when the volt and ampere capacity of a motor, are known.

Armature resistance, depending on the size, length and quality of wire used in winding, being once fixed, cannot be changed by any variation in section of armature core, shape of teeth, or length of air gap.

In the same way, magnet coil resistance, depending on size and weight of wire, fixes the loss for magnetizing power, and this cannot be varied by any change in pole pieces or area or length of magnet core.

If size and length of armature wire are not known, the armature resistance may be easily found by noting volts between brushes when a current as nearly as possible equal to the full capacity is sent through the armature, the magnet coils being disconnected and armature at rest, by the formula, $\text{amperes} = \frac{\text{volts}}{\text{ohms}}$.

As the volts between brushes will in many cases be small, a voltmeter reading to tenths should be used for the above reading.

When the armature resistance is known, the rate at which work is lost in it can be found from the formula, watts = (amperes)$^2$ × ohms, the amperes used in this formula corresponding to full load of motor, and the ohms being those found for the winding.

If magnets are series wound, the resistance and loss in winding can be found by the same means as for the armature.

Should magnets be shunt wound, an ammeter reading at least to tenths should be connected in coils when they are taking current from the supply line at rated volts of motor.

The reading in amperes and the volts of line give the expenditure of watts in magnet coils from the formula

Watts = volts × amperes.

Iron losses may be conveniently divided into those from local currents and those from hysteresis.

Local current losses occur in pole pieces when armature slots and air gap are not properly proportioned; also in armature cores when the discs are not properly insulated from each other. All these losses, however, are reduced below one per cent in well-designed motors.

Hysteresis losses result from magnetic reversals in the iron armature core, and cannot be avoided, but their amount can be maintained at a small figure by the use of the best iron or steel for the purpose.

The amount of loss due to hysteresis depends on the weight of iron in the armature core, the saturation, or webers per square inch of section, the rate of reversals and the quality of iron used.

As the quality of iron and the saturation of armature core cannot be easily found after a motor is completed, it is not convenient to find the hysteresis loss independent of friction, but for motors from 1 to 10 h.p. of good makes, hysteresis losses are from 1 to 3 per cent.

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Work is done to overcome friction in a motor between shaft and bearings, brushes and commutator; also between the armature body and the air.

The most ready and convenient way to determine the sum of hysteresis and friction losses in an electric motor is to connect the unloaded armature, together with a voltmeter and ammeter, to the supply mains of the rated pressure, and then note volts and amperes at the armature terminals.

The watts found from these readings include nearly all the friction local current and hysteresis losses whatever the load; also an additional loss due to noted amperes flowing through the armature resistance.

The loss due to armature resistance when the motor runs empty is found from the formula, watts = (amperes)$^2$ × ohms, in which the amperes is the armature current. This loss in watts being deducted from the total watts for free operation, represented by watts = volts × amperes, leaves the total watts lost as local currents, friction and hysteresis.

Watts due to loss in armature-winding with full rated current, plus watts lost in magnet coils, plus watts due to local currents, friction and hysteresis, as obtained above, give a sum total of losses in the motor at full load.

The total watts taken by the motor from the line, at full load, minus the total losses as above found, and then divided by the total watts, gives the motor efficiency, which may be expressed by the formula

$$\text{Efficiency} = \frac{\text{total watts from line} - \text{watts lost in motor}}{\text{total watts from line.}}$$

To show about what may be expected in motor efficiency, the accompanying table has been prepared, giving watts lost in armature winding, magnet coils and for friction, local currents and hysteresis combined, also full load efficiency for motors from ½ to 10 h.p. as commonly made by first class concerns.

Poorly made motors of much worse efficiency than given in the table can be found on the market, and it is also true that motors of better efficiency can be had, but the table is intended to show efficiencies which any well built motor may be expected to show.

Watt losses in armature and magnet windings shown in the table are what the writer knows to exist in many motors now on the market, by actual computations based on the resistance of these windings.

Watt losses due to friction, hysteresis and local currents are based on data from various sources and correspond very nearly with many actual tests.

Motors of various makes will be found to vary in relative watt losses of armature and magnet windings; some motors, for example, have a much larger loss in the armature coils than above indicated, with a corresponding decrease of loss in the magnet winding.

Motors with windings proportioned in the last named manner are intended to give a high efficiency at partial loads, but there is more tendency to spark on change of load and overload than with the more usual proportion of windings.

As may be noted from the table, losses due to hysteresis, local currents and friction are in most cases greater than the winding losses, contrary to the more common idea, and in the matter of local currents and friction some gain in efficiency may be expected.

DATA OF SMALL MOTORS.

| Watts Delivered to Motor. | H. P. Delivered by Motor. | Watts Lost in Armature Winding. | Watts Lost in Magnet Coils. | Watts Lost Friction Local Current Hysteresis. | Total Watts Lost. | Full Load Efficiency. |
|---|---|---|---|---|---|---|
| 548 | ½ | 40 | 44 | 91 | 175 | 68% |
| 995 | 1 | 65 | 60 | 134 | 249 | 75% |
| 1,913 | 2 | 110 | 99 | 212 | 421 | 78% |
| 2,798 | 3 | 180 | 110 | 320 | 560 | 80% |
| 4,648 | 5 | 170 | 176 | 473 | 819 | 82% |
| 6,661 | 7½ | 220 | 220 | 626 | 1,066 | 84% |
| 8,674 | 10 | 260 | 264 | 690 | 1,214 | 86% |

Cost of construction is the present, and seems likely to remain in the future, the practical limit of efficiency, the fact being that present efficiencies can be somewhat increased if expense is not regarded.

In the case of a 10-h.p. motor, the efficiency can be readily raised to above 90 per cent, but at a considerably increased cost.

As motor users come to understand the relation between motor efficiency and cost of power, efficiencies may be expected to approach the absolute limit.

## COMPRESSED AIR AND LIQUID AIR.

The scope of electrical engineering is so great that a new development in almost any branch of the mechanic arts is of immediate interest to electrical engineers, hence the interest taken by this class in the recent revival of compressed air traction in New York City, following as it does so closely upon many optimistic statements about liquid air, a commodity so new that fallacies concerning it are difficult to disprove. In the storage of power by means of compressed air, the air is, as a rule, compressed to several thousand pounds per square inch in order to economize space. It is then expanded through a reducing valve to a pressure of perhaps 150 or 200 pounds before it is used.

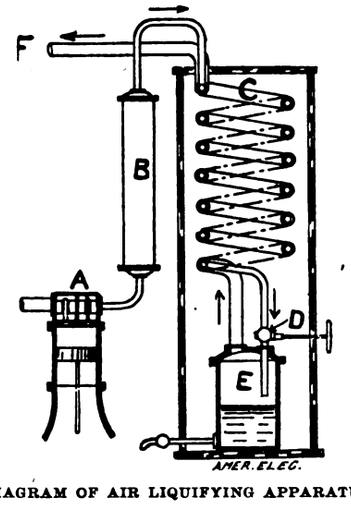



DIAGRAM OF AIR LIQUIFYING APPARATUS.

With liquid air it will be possible to economize to a far greater extent in space, and that without the use of heavy and expensive steel flasks and the dangers that accompany extremely high pressures. The air that could be compressed with a pressure of 1000 pounds to the square inch into a tank with a volume of 11½ cubic feet, would only fill 1 cubic foot in the liquid state and could be kept in the latter under no pressure but with a free vent to the atmosphere, the vaporization being minimized by careful heat insulation, which would be necessary on account of its extremely low temperature, which would be about 300 degrees below zero F.

The extravagant claims recently made concerning the power which liquid air will exert give a false idea that it contains a great amount of stored energy, which is quite the reverse of the case, the liquid state representing the absence of energy from a given amount of air. To obtain any power from it it must necessarily be given heat just as water must be subjected to heat to obtain power for the steam engine, and just as compressed air is heated in the traction system now operated in New York City. The most glaring fallacy concerning air recently published is the statement to the effect that by using a certain amount of it in machines a greater amount can be generated. That this violates the fundamental law of conservation of energy has been vehemently stated, but is a difficult matter to prove, in that the liquifaction does not consist in giving energy to air, but in taking energy from it.

In a sense liquid air does generate itself when made by the process invented by Dr. Linde of Munich and adopted by Mr. C. E. Tripler of New York, the instigator of some of the fallacies. The general principle of the apparatus is shown in the accompanying diagram, where A is a pump compressing air to several thousand pounds pressure per square inch in the receiver B, where it is cooled and passed at full pressure into the inner tube of the concentric pair of tubes coiled as shown at C. The air is allowed to escape through a valve D, into chamber E, fitted with a vent through the outer tube of the coil, and thence to the atmosphere at F. By a well known law of thermodynamics, a perfect gas, when it expands without doing mechanical work as through an orifice, does not change in temperature, but if the gas is so compressed as to approach the condition of a saturated vapor, it will, when expanded through an orifice, be reduced in temperature. This is the principle of ammonia and carbonic acid gas refrigerating machines.

The cooled air escaping from orifice D rises through the outer tube of the coil and further cools the incoming high pressure air in the inner tube, which becomes still cooler in expanding through orifice

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D, until finally the temperature becomes so low that part of the air expanding from D is liquified. It will be seen, however, that the liquifaction absolutely requires compression which absorbs power, and this power is enormously greater than any that can be obtained by the most perfect machine, utilizing all the power which the air would give in re-expansion to the atmospheric condition under normal temperature.

## LIGHTNING AND LIGHTNING ARRESTERS.

BY HENRY E. RAYMOND.

The discussion which has been started relative to the behavior of different types of lightning arresters, under certain fixed conditions, has proved very interesting to me, and I trust that others have also been interested to an extent which will warrant a rather more extended recital of experiments in this line, and the conclusions reached thereby. Some years ago I was interested personally in the disastrous effects of lightning on high tension lines, and came to the conclusion that either there was not enough known concerning the action of these discharges, or that what was known was insufficiently or improperly applied.

Most of the troubles were caused by using arresters with too great a striking distance, and conversely by the destruction from arcing of arresters having a low point of break-down. The conditions varied so greatly that it seemed impossible to strike the mean relation. After reading every thing I could find on the subject, I made a lot of crude and rather blind experiments, using the Leyden jar arrangements, as described by Prof. Lodge, and also using static electricity from belts in connection with condensers.

I tried the old idea of stringing two wires parallel, and grounding one. The grounded wire would divert a brush discharge from the insulated one, and diminish the volume of a disrupted one. Then I tried a lot of equally simple experiments with high potential and commercial frequencies. The whole lot did not amount to much, except in that they showed a difference between their results and the action of a line discharge, and consequently suggested doubts as to their value.

Th actual behavior of all my devices connected with an overhead line was very noticeably different from the results pictured by Prof. Lodge, and later by Mr. A. J. Wurts.

It was once stated to me that a high ohmic resistance in the shape of a tank of water, if connected directly from the line to earth, would tend to dissipate the charges on a line. I tried this, and found that unless the tanks were very large, or unless a prohibitive current leakage was allowed, there would be little tendency for any discharge to earth through the tank. A short length of tank in series with a gap, however, has done very effective work.

I let this experimenting drop for a year or so, and took notes on the action of a number of different types of arresters installed on working lines. The arresters were so situated that they could all be observed at one time from one point, and the discharges which passed through each counted and critically noted. It is the purpose of this article to compare the behavior of the sparks, which jumped the arresters, with that of artificially produced discharges, which were applied to similar arresters under similar conditions. The primary idea was not to find which of two or more arresters presented the least opposition to a disrupted spark, but to obtain sufficient data from which to draw reasonably correct theoretical inferences. Incidentally, it was expected that the best form of gap and path would be found, and that also it would be found to what extent the best forms were influenced by dynamo current, etc.

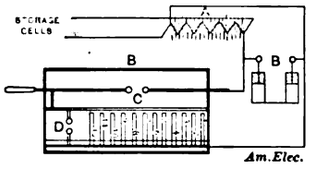



FIG. 1.—RESISTANCE FRAME, INDUCTION COIL.

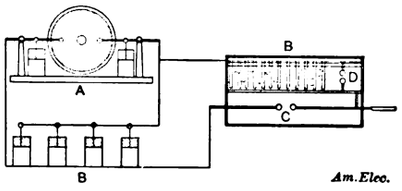



FIG. 2.—RESISTANCE FRAME, HOLTZ MACHINE.

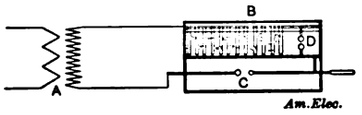



FIG. 3.—RESISTANCE FRAME, HIGH POTENTIAL TEST.

As may be seen in the cuts given herewith, the experiments were conducted along different lines and under several sets of conditions. The primary sources of electrical tension were an induction coil, a Holtz plate machine, and a high potential transformer. It was developed early that the number and disposition of Leyden jars did not materially affect the value of the tests. That is to say, that apparently the most trying conditions under artificial means of discharge was when but few jars were employed. Therefore, as a matter of convenience, the final experiments were all made with the jars arranged as in Fig. 1.

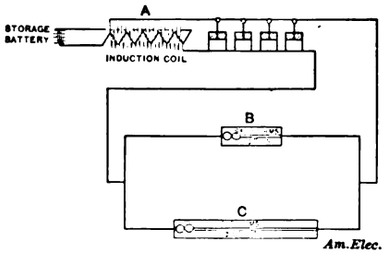



FIG. 4.—ARRANGEMENT TO TEST RESISTANCE OF VARIOUS LENGTHS, FORMS AND VOLUMES.

In order to determine the relative impedance or reactance of ohmic resistances equal in length, but unequal in resistance, when placed in the path of a disruption discharge, the device B in Fig. 1 was made. The same arrangement was tested as shown in Fig 2 and Fig. 3. A is the source of energy; B, the frame holding the rods; C is an adjustable gap in series with the path of discharge, and D is an adjustable gap in multiple with the resistances. These resistances, which varied from 10 ohms to 5000 ohms, were arranged parallel to each other. One end of each was joined to a common connection, the others separated by small equal distances from a rod which constituted the other side of the gap under test.

It is interesting to note that in these cases the sparks when once started were identical for respective resistances. The very high frequency of the Leyden jars discharge and the low frequency transformer spark were both affected by the resistance in that the volume or quantity of discharge was for each rod inversely proportional to the resistance. The Leyden jar discharge took a longer no-resistance gap than the high potential transformer discharge did. The rods of lower resistance, from 10 to 60 ohms, appeared to have about equal effect on the discharge used.

Using the Leyden jars, the gaps were then varied so as to obtain equivalent striking distances, and as near equal volumes of discharge as possible. It will not be necescary to give all the figures in detail. The highest resistance had in series with it a gap one-third the length of the metallic gap, and one-half the length of those in series with the lower resistances. The longer the gap at C, the greater was the voltage and quantity of the discharge, and the more marked was the opposition of the resistance to the passage of the discharge.

The arrangement in Fig. 4 was used to test the relative opposition of resistances of various lengths, forms and resistance. It was found in one case that when C held a resistance of 340 ohms 24 ins. long it offered as great a resistance as did B when it held a resistance of 2500 ohms 6 ins. long. This increase of impedance due to length is especially noticeable in the use of Leyden jar discharges. To a lesser extent it is noticeable on line discharges, as evidenced by the non-success of long tanks to ground, and the success of same when shortened and put in series with a gap. A considerable length will tend to retard the discharge if it be of equivalent resistance. An exceedingly small surface, however, will do so to a greater extent.

It has been asked lately why discharges do not "leak" away from a railway line through the car lamps. Probably for the same reason that my line discharges would not pass through the long tanks directly to ground. The length is too great for the resistance and cross section and corresponding surface. In spite of this, though the discharge frequently passes

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through several lamps, short-circuiting the others, I will venture to state that there are more instances of this than of motor burn-outs.

The natural conclusions which would be drawn from the results of these experiments are that where a resistance is placed in the path of a discharge, it offers a choking effect, and tends to impose a greater opposition than a certain relative gap would; and that an arrester containing in its circuit an ohmic resistance would be less effective than one consisting solely of metallic discharges. The suppression of the dynamo current must be provided for, however, and this in the no-resistance types necessitates a somewhat longer gap. There are, of course, certain relative values for resistance and gaps in parallel to obtain equal sparking conditions, but these values vary so much with the nature of the discharge that no definite relation can be determined from these tests for the practical conditions of service.

Besides the action of varying discharges influencing the relative proportions of resistance and gap in parallel, is the very important factor introduced by the size of machines. We all know that an arrester may be designed which will readily prevent passage of current from a small dynamo or plant, but which, when placed on a circuit operating from large ones, will hold an arc every time.

A non-arcing arrester will interrupt an arc from moderate sized machines with three gaps 1/64 inch for each 1000 volts. In order to interrupt an arc backed by several thousand kilowatts this same arrester will often need as much as from 5 to 8 gaps for each 1000 volts.

The arrester with resistance in circuit has the advantage in that the resistance practically eliminates the factor which the size of plant kilowatt capacity introduces.

While it is probably true that these little experiments may give us an idea as to the possible action of an arrester on a line wire in commercial operation, it is not likely that they will prove in any way conclusive. It is a dangerous matter to jump at conclusions when considering such an agent as lightning and its effects, and, recognizing this danger, I have spent a number of years observing, at all times of the day and night, the actual behavior of discharges from lines when in operation and when idle, and have collected a considerable amount of data on the effects which resistance, different gaps, air, mica, etc., have on the visible action of electrostatic discharges. Comparison between these results and those from the artificially produced spark showed a marked dissimilarity.

It was easy to prove that the Leyden jar discharges were of high frequency, and to note the effect this frequency had upon the various experiments made. The rapidity of oscillation naturally made the insertion of resistance a marked factor, and the absence of inductance in any amount made more pronounced the tendency of the discharge to jump the metallic gap with no resistance in series, in preference to one which contained a certain ohmic resistance. I believe that the common idea that lightning discharges possess enormous frequency of oscillation is a fallacy, and that the Leyden jar discharges have a frequency far in excess. It seems probable that under most conditions atmospheric discharges have a frequency of but a few thousand periods, or even a few hundred, while these condenser ones have oscillations of several hundreds of thousands.

It was noticeable in the Leyden jar tests that the lower the voltage of discharge, the less was the factor of impedance introduced by the resistance. That is to say, the less the exciting current and the shorter the series gap, C, the less the tendency to avoid the resistance; and conversely, the greater the quantity and voltage of discharge, the greater the tendency to avoid resistance. Now, from these facts we may deduce readily the following ideas:

First, that discharges of low frequency are much less affected by resistance than are those of high frequency, and, as a corollary, a discharge but slightly opposed by resistance is presumably of low frequency. Second, the greater the capacity of the circuit, the less resistance influences the discharge. Third, that a circuit containing great inductance and capacity will permit of discharge but slightly affected by the resistance in circuit, if in short lengths. These hold good for moderate lengths of resistance with reasonable surface, and are influenced by the amount of resistance in ohms much less than by the length of the same.

As to the conditions tending to produce these factors, we may judge with considerable accuracy. We know that the higher the capacity and self-induction of a condenser and the connecting circuit the lower will be the frequency of the discharge oscillations. We know that the larger the capacity of the condenser, the lower will be the voltage a certain charge can produce.

With these considerations in view, we can hardly place much value upon such laboratory experiments as I have described here, and such as have been referred to from time to time. The circumstances attending the action of long overhead lines would be difficult to approximate in the laboratory. We might obtain a relative capacity and an equal induction, but not an equivalent one.

We could not approximate the many external influences. We could not produce a discharge similar to atmospheric ones, in their low frequency, without a capacity in condensers and an inductance which would be impracticable from their distributed condition.

One might naturally ask here, "why should I not place my confidence in laboratory tests, and what known reason is there on which to base distrust of their value?" The best answer I could give would be a description of some observations and experiments I have made with arresters connected to a line. It will not be necessary in this case, any more than in the description of the jar experiments, to go into any great detail, nor to give many of the figures and tests, so I will just give a few of the most distinctive ones.

One of the first to suggest itself was the arrangement shown in Fig. 6. The purpose of this was to see what benefit a reactance coil was in a line wire. It had been supposed that this coil would offer a great impedence to the supposedly high frequency discharges. It apparently did nothing of the sort, for, with no machine on the line at this point, the discharge would jump both arresters about equally well, although the arrester B was the choice. When the machine was running, the tendency for B to discharge was far greater, and B would often rapidly discharge, while A was entirely inactive.

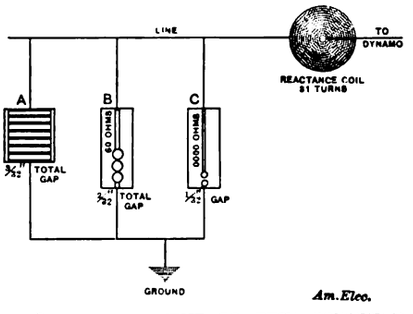



FIG. 5.—ARRANGEMENT TO TEST COMBINED EFFECT OF RESISTANCE AND GAP.

This I lay to the fact that the capacity of the dynamo with the small inductance of the section, as compared with the whole line, produced discharges of high frequency, which were beaten back from A by the coil in the line, and had to pass B. It is not difficult to picture the possible result of the practice, now so common, of putting in choke coils indiscriminately and providing no discharge path from the dynamo side of the coil.

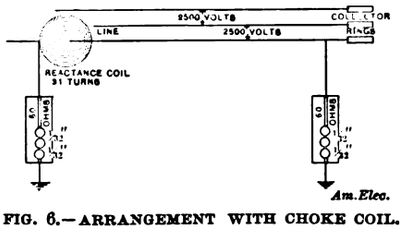



FIG. 6.—ARRANGEMENT WITH CHOKE COIL.

Fig. 5 shows an arrangement designed to test the combined effects of resistance and gap form. As may be seen, A has six gaps 1/64 in. each, and no resistance; B has two gaps 1/32 in. each and 60 ohms resistance, 6 ins. long, ¼-in. diameter; C has one gap 1/32 in. and 6600 ohms in series.

In a future issue the results of experiments on lines in service will be recounted and discussed.

**The Sale of the Fort Wayne Property.**—The Fort Wayne Electric Corporation's plant and other property were purchased by the General Electric Company at the receiver's sale on April 18th for $356,400, of which sum $185,000 was returned to the General Electric Company for the debenture bonds of the Fort Wayne Corporation which it held. The balance, with collectable accounts, etc., amounting to $150,000, will be disbursed in part payment of the indebtedness, which is $900,000.

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## ECONOMIES FOR SMALL MANUFACTURERS.

BY LYMAN C. REED.

Some very recent and glaring examples of the energy wasted through ignorance, by small manufacturers, having come under the notice of the writer, it seems that a profitable field for the consulting engineer should be open in this direction.

Small manufacturers when within reach of a central station, as a rule, prefer electrical energy to other forms, as it is the cleanest and easiest to handle, and in most cases by far the cheapest. That the proprietor fails to study his needs before buying his motor or installing his machines and shafting, is frequently the cause of a certain waste of energy which shows each month on the meter bills, but is not otherwise perceptible. It is this class of installations which are discussed below, with the endeavor to point out the main errors which occur in the original setting up of the machinery and motor.

We will take, for example, the case of a small printing establishment which came under the writer's direct notice, and give in detail the results accomplished by a careful test of the machinery and motor. The machinery consisted of three small "donkey presses" belted to one line of shafting, and capable of being run by foot power if the current from any cause failed. To the same shaft was belted a countershaft, from which a large press was operated. The belts were abnormally heavy, being from 6 to 8 inches wide, the proprietor evidently being under the impression that he was using a great deal of power.

The motor, a five h. p. Eddy bipolar 500-volt machine, ran at 1800 r. p. m. and was belted to a counter-shaft, which, in turn, ran the main line of shafting at 150 r. p. m. The efficiency of the motor was found to be 80%, and the total work required of it was 2.3 h. p., including the amount consumed in running the motor. It was found that 1 h. p. was being used by the motor alone, and 1.3 h. p. for the total work required, with everything running at full load. The shafting was found to consume 0.6 h. p., leaving only 0.7 h. p. to represent work done. The enormous loss is readily appreciable, as only 30% of the power consumed was available in actual work.

An efficient remedy was applied by cutting down the belts and changing the motor from 5 h. p. to 2 h. p. The small motor had the same efficiency as the larger one, namely 80%, and ran at 1950 r. p. m. Pulleys of the same size were used, so that 8% more work is now done in the same time. The 2 h. p. motor requires only 0.4 h. p. to operate empty, thus saving 0.6 h. p. and bringing down the total load to 1.7 h. p., which is well within the rated capacity of the motor. As the large press is used only for a few hours per day, the average working load is about 1.2 h. p., against a former average of 1.8 h. p., giving a net saving of 33 1/3% in the operating expenses of the installation, with 8% more work accomplished. A total saving of about 40% is made by the change. The shafting and machinery were all in good order and apparently, to the proprietor, everything was ship shape. This illustration is only one of the many which come to the writer's notice and which emphasize the fact that a little money spent at the start in obtaining expert advice would, in the end, very greatly benefit the manufacturer.

Shoe manufacturers, as a rule, use motors often of twice the capacity they need, simply because they are ignorant of the amount of energy required for the machines they have. The machines may be all labeled with the amount of power required to run them, and in figuring up the size of motor they wish to buy, these amounts are generally added together to obtain the size required. As a matter of fact the period a machine is not in use equals and often exceeds the time it is running, and the general average where a large number are running is about half the rated output of the motor.

An illustration will probably be the best way of clearly showing the losses incident to lack of forethought in this direction. A shoe factory, running some 20 machines for the various processes of shoemaking, installed a 20 h. p. multipolar motor of a standard make, running at 850 r. p. m. The load, when everything was on loose pulleys, averaged about 5 h. p., including the losses within the motor.

The general operating load averaged from 7 to 10 h. p., never going above the latter figure. The motor, running empty, took 2.66 h. p., showing that its efficiency had been sacrificed to speed. The number of hours the motor ran was carefully recorded and it was found from the record of a Thomson recording wattmeter that the average throughout the month was 8 h. p. The efficiency of the motor under this load, therefore, falls as low as 66 2/3%.

The prime remedy to be applied in a case of this sort is to install a motor of 10 h. p., with an efficiency of 90%, which is easily attainable by increasing the speed to say 1500 r. p. m. A total saving of 21% is accomplished at the average load of 8 h. p., and 23 1/3% if the load averages 10 h. p.

On an average net bill of $100.00 per month, the amount saved by substituting the 10 h. p. motor for the 20 h. p. is $250.00 a year beside the first cost of a 10 h. p. motor being about 1/3 less than a 20 h. p. The average manufacturer without a mechanical or electrical education is completely at the mercy of contractors, who, of course, try to sell as large a motor as possible and put up as much shafting and pulleys as they can well crowd in.

Numerous examples could be given of first class installations where all the machinery and apparatus were the best obtainable, and yet certain wastes were taking place which could in no wise be ascertained without a thorough test. It is almost safe to say, and we do not say it without ample data at hand to prove the assertion, that an average of 15 to 20% can be saved on the common run of installations of a similar character after carefully looking into the conditions which exist.

A prolific source of wasted energy was the now almost obsolete belted elevator where the motor and shafting ran all day irrespective of the service required of the elevator car. As high as 90% of the energy used has been found to be consumed in simply running the motor and shafting.

As a rule what goes up in an elevator eventually comes down, hence the only energy that should be required is the overcoming of the frictional resistance occasioned by the movement of the car and its necessary appointments. This of course has never been fully attained, but the present method of direct connection reduces the loss to the minimum obtainable from smooth running and well designed machinery.

Manufacturers are sacrificing to slow speed the efficiency of their motors, as recent tests on some of the best makes show. A bipolar 18 to 20 h. p. motor running at 1500 r. p. m. should not take over 1 h. p. running empty, if well designed, and the increased power consumed in reducing the speed by a countershaft—should space for a large pulley be lacking—should never exceed 0.2 h. p.

The essential point in buying any motor is to ascertain its efficiency and then get as small a motor as possible to do the work required. A slight overload for a few minutes, or even an hour's duration, will not hurt the machine, and the nearer the motor is worked to its full capacity the greater amount of available energy can be utilized at the machines.

The cheapening of a product always produces an increased demand and more universal application, and along these lines it will be found of great benefit to the central station to help as far as possible in seeing to it that the ignorant consumer is not uselessly wasting the energy for which he pays.

Many complaints by consumers are made in a general way on high bills. The meter is tested and found correct, no salient defects are noticed by the adjuster, and the payment of the bill is demanded on its merits. A little care and a close attention to the consumer's needs by the central station would, in many cases, prevent hard feeling and at the same time secure an ardent advocate of the use of electricity as a motive power.

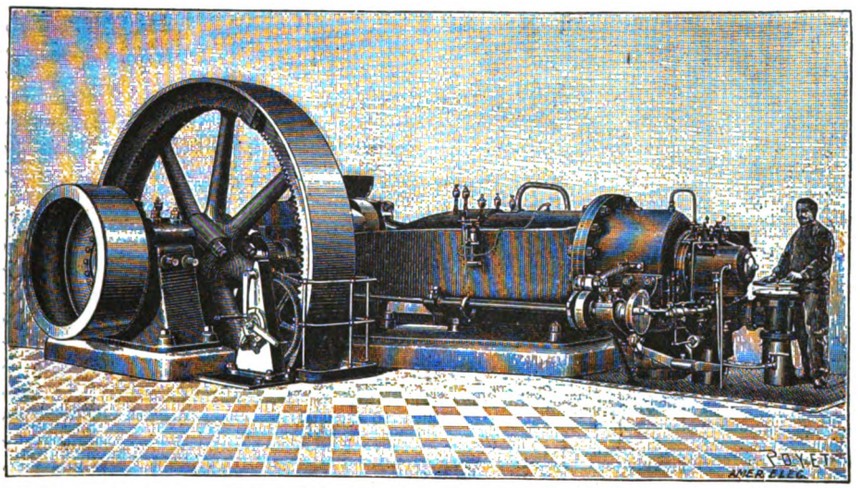
The many uses to which electricity is put in the running of all sorts of machinery make the study of efficiencies and the resulting economies in operation a profitable as well as fascinating one. The kaleidoscopic nature of the problems presented keeps the electrical engineer constantly on the alert and makes the time-worn battle cry, "A penny saved is a penny earned," the slogan of the onward march of electrical development.

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# Among our Foreign Contemporaries

**Electrical Energy from Blast Furnace Gases.**—Much has been written lately in the foreign journals calling attention to the enormous waste of energy in the gases which escape from blast furnaces for the manufacture of iron from its ores. These wastes are so enormous that the power from a few furnaces would be enough to run quite a large central station. Not only is there a waste in the gases which escape unused, but those that are used for heating boilers are also largely wasted because they are not well adapted for running steam boilers. A recent article by Mr. Witz in "L'Eclairage Electrique" gives some figures which are of interest and give a very good idea of this enormous waste. A hundred ton furnace, for instance, wastes about 2000 h.p. in the gases, part of which is used for auxiliary machinery, leaving, however, an enormous amount which is absolutely wasted and could be utilized by electrical transmission. Furnaces of 150 to 200 tons capacity are not rare, there being one in America using even 700 tons every 24 hours, in which the material for combustion is reduced to three-quarters or a ton per ton of iron. A thermic balance sheet is given in which the heat units for 24 hours have been worked out, which shows that the charge of about 92,000 kg. of coke contains 629 million heat units; to this must be added 416 million which is recovered from the re-heaters, making a total of 1045 million. That consumed by the chemical reactions in the furnace amount to 182 million; that utilized for re-heating 473 million; that utilized for the production of steam 50 million, leaving about 340 million calories, or over half that in the coke, as wasted energy escaping with the gases. The portion which develops steam for the engines is utilized very uneconomically at the rate of at least 22 cu. m. of gas per indicated h.p. hour, which is at the rate of only about 3 per cent. efficiency. With the aid of gas engines only about 3.5 cu. m. of these gases is required per h. p. hour, and at this rate, if the gases now used in the boilers are consumed in gas engines instead, the horse power obtained would be 2381, instead of 380, as at present with steam engines. This would involve the use of very large gas engines, which have heretofore been considered impracticable, but they are now being built for 200 and even 500 h. p., the latter with double cylinders being readily increased to 1000 h. p. An engine for 180 h. p. at 87 per cent. ignitions is shown in the adjoining illustration, which will give some idea of the size.

The diameter is 800 mm., the stroke one meter and the speed 105 revolutions; it appears that there is one ignition for every four movements of the piston. It has run continuously for 120 hours without a single premature ignition. The tests made were made by that writer himself, who is an authority. It is proposed to use the remaining 1900 h. p. from a hundred ton furnace to operate the dynamos of a central station for distributing the power. A group of such furnaces is therefore quite as valuable a source of power as a large waterfall. It is even argued that when these gases are utilized the iron produced by the furnaces may be considered as a mere bi-product.



A GAS ENGINE USING BLAST FURNACE GASES.

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**Wehnelt Interrupter for Induction Coils.**—Much has appeared in the foreign journals concerning this simple and curious device for replacing the make and break of an induction coil; it was fully described in the March number of the "American Electrician." Among all that has been published the following extracts may be of interest: A very curious result was obtained when an ampere meter for measuring the primary current was placed in circuit, it was found that when the induction coil was short-circuited, that is, cut out of circuit, the current became very much less, an apparent paradox. Thus with 70 volts the current was 20 amperes when the coil was in circuit and only 15 when the primary was short circuited; with 110 volts the difference was even greater, the current being 25 amperes with the coil in circuit and only 4 to 5 when it was cut out. Numerous observers have experimented with alternting currents and it was found that the interrupter acted quite well with such currents, but it seemed to operate only with the waves in one direction and then only at the moment when the current was sufficiently great. The effect is therefore not as good as with direct currents, but it has the advantage that the secondary current is similar to that obtained when a direct current is used in the primary, that is, for vacuum tube experiments it is practically a unidirectional current; the apparatus therefore enables a pulsating direct current to be obtained from an alternating one, although not very efficiently. Some observers found that the apparatus is apt to become fatigued, that is, after running a while it refuses to operate properly; some believe this is due to the heating of the liquid, while others found that this was not the case, as it became fatigued even when the liquid was cooled with a bath. One experimenter found that the fatiguing could be remedied by momentarily reversing the current. As the glass tube in which the platinum wire is fused is apt to crack, it was considered better by some to use an ebonite tube and pass the platinum wire through a small hole in the bottom. Another method would be to use very thin glass. It also seems better to make the platinum as short as possible and use mercury or a thick copper wire leading to the inside end of the platinum, in order to carry off the heat. When the self-induction is diminished the frequency rises and with no self-induction at all the apparatus will not work. It was found that the platinum point had a capacity like a condenser and that this, together with the self-induction, produced what is known as a resonance effect. This would mean that a careful adjustment of the self-induction may be required to produce the best effects. Frequencies as high as 4000 were obtained by one experimenter and as low as 2 or 3 per second by another. It was also found that the apparatus would work equally well with a solution of potash instead of sulphuric acid, the advantage of that being that an iron vessel may then be used for the solution, acting at the same time as the other terminal in the place of lead. Two interrupters in a series act in general like a single one of half the capacity. The apparatus works better when a stream of acid flows past the anode to remove the bubbles. A somewhat surprising result was obtained in that the spark length of small coils was very greatly increased, while with large coils the gain was not nearly as great. With small coils giving 6 c. m. sparks, for instance, it was possible to obtain two and even nearly three times the spark length, while with large coils

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there appeared to be a maximum spark length of 20 c.m.; it was likely, however, that this may have been due to the fact that the most favorable conditions were not obtained; it is argued that the primary current does not have time to reach its maximum in those large coils before it is interrupted and therefore the induction is not so great. A modification, which scarcely bears much resemblance to the original, was suggested in a London paper, in which a large globule of mercury was substituted for the lead plate, distilled water for the acid, and an aluminum wire for the platinum, the wire being brought close to the mercury. It is said that the mercury will periodically contract and thus operate as an interrupter. It is claimed that this form will operate with a low voltage and a small current.

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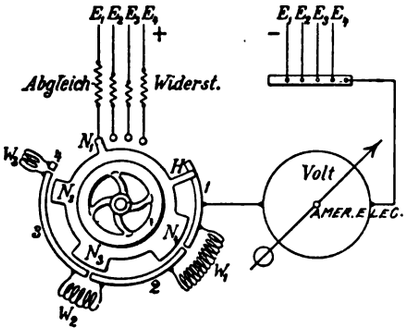
**Induction Coil Interrupter for Alternating Current.**—Although an alternating current seems at first sight to be very suitable for the primary of induction coils, yet it has not been found to be so in practice and those who have access to an alternating current lighting circuit only, for operating their coils, are compelled to use batteries or accumulators. An ingenious form of make and break for such cases was recently described by Mr. Villard in the "Revue Generale des Sciences." It consists essentially of a tuning fork, which in the usual way with sliding weights is tuned so that it vibrates synchronously with the alternating current of the circuit. The end of one prong of the fork has a stiff wire attached to it, which passes between the poles of a permanent magnet, which should be made of a thick, hollow cylinder, opened so as to present long narrow pole faces parallel to which the wire passes. The alternating current is passed through this fork and the wire, which will cause the fork to vibrate and the end of the wire is then made to dip into mercury; the current will thus be broken only when in one direction and the coil will therefore act as though it were supplied from a continuous current source.

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**High Resistance Wire.**—Another new alloy for high resistance wires is being brought out in England and is mentioned in a recent note in the London "Electrician." The tests made by a certain standardizing institute showed a specific resistance of 85.13, presumably microhms per cu. cm. at 20°C; the temperature coefficient is 0.0007 and the specific gravity 8.1. It is claimed that it can be heated to 650°C wthout fear of injury. This specific resistance is about like that of the Krupp alloy and is considerably higher than that of manganine.

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**Measuring the Voltage at the Ends of Feeders.**—When, as is is usual in a central station, a number of feeders run out in different directions, all being connected in multiple, and it is then desired to indicate at the station the mean voltage at the distant ends of these feeders, some difficulties arise. It has been claimed that if the potential wires which are used for that purpose and run from the station to the ends of the feeders, are all made to have the same resistance, and if the station ends are then all connected to the same voltmeter, its reading will be the mean of the different voltages at the ends of the various feeders. This, however, is shown by Dr. Teichmueller in the "Elektrotechnische Zeitschrift" leads to errors, which, in an example, was shown to be over one volt for ordinary 100 volt circuits, an error which is too great to be neglected. Still greater errors are produced if that same voltmeter be used also with a single pair of potential wires, or worse yet when it is used for measuring the voltages of dynamos or bus bars at the station; errors of 5 to 6 per cent. can thus be made, the reason being that the potential wires have certain resistances and that by using more or less of these or none at all, the indications of the voltmeter will be different. He then explains how to overcome this by means of a switch shown in the adjoining cut, the principle of which is simply




A PILOT WIRE EQUALIZER.

that the instrument is calibrated once for all with a certain external resistance in series with it, say about 100 ohms; the external resistances are then so arranged on this switch that in any case the external resistance is equal to the same 100 ohms whether one, two or more pairs of potential wires are used. In the illustration shown there are four sets of potential wires; all the negative ends are connected together to one pole of the instrument, while the positive ends are first connected to equalizing resistances, which make the resistance of each pair equal to that of any other. The switch shown below these is arranged, as will be seen from the figure, so that none of its three resistances are in circuit when the voltages are measured at any single pair of wires, as is shown in the position indicated. When the switch is moved to the right so that the lug N comes in contact with the ends of the potential wires, thus connecting any two of them together, the resistance $W_1$ will be in series with the volt meter. Turning it still further so that three are in multiple, the second resistance will be switched in circuit and so on. This apparatus has been adopted by one of the leading companies in Germany.

**Insulation Recording Instrument**—An instrument for periodically recording the insulation resistance of a network of wires, recently devised by Travilleur, is described very briefly in the London "Electrician." It is based on the principle that when a voltmeter is connected between one of the wires and the earth, and a reading taken, after which it is shunted by a known resistance and another reading taken, the insulation resistance of the network may be calculated from these two readings, knowing the resistance of the shunt and the voltmeter. The instrument is an ordinary voltmeter whose shunt is automatically switched into circuit once an hour by the same clockwork which revolves the drum on which the record is made. The resistance of the voltmeter and shunt in this case were 1200 and 500 ohms respectively for 200 volts between the outer wires, or double this for 440 volts between the outers. It may be used for two or three wire systems, but unfortunately it is limited to those cases in which the middle wire is not earthed.

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**A Simple Way of Measuring Illumination.**—In a recent paper read before the French Academy of Sciences a very simple and convenient method of measuring illumination, such as that of daylight, was described; it has the advantage that no standard lamp need be used, but, on the other hand, it gives only relative values and requires the use of sensitive paper. The apparatus consists of a box having a succession of any desired number of holes; the first is covered with a single film of collodium, tinted with a coloring matter called aurentia; the second has two such films, the third three, and so on. Underneath these is exposed a strip of sensitive paper, that made of prussiate of iron being thought to be preferable. The exposure must, of course, be for a definite length of time in each measurement. After developing the images of these holes will have various degrees of density of color. If the holes have numbers marked on the films, then the highest number which is readable on the sensitive paper indicates the relative illumination. By standardizing such an apparatus with a standard source of illumination it might be possible to obtain quite fair results. It would seem, however, that such a method may be largely dependent on the color of the light and the chemical rays which it contains, and that it is not dependent alone on the true illumination in foot candles. The rays from the arc light, for instance, are somewhat different in that respect from those of the sun; for relative measurements, however, of the same source of light, quite good results might be obtained.

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**New Method of Compounding.**—What seems to be a rather interesting and novel method of compounding was recently devised by an English electrician named Sayers, and consists in the use of a third brush, the field being excited between one of the main brushes and this third brush, which is placed a short distance from the

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other main brush. It is claimed that such a machine will be self-regulating for voltage at different loads and that it may even be made over-compounding. It was natural to suppose that this would produce inequalities of the field and that there would be bad sparking under this third brush, but Mr. Feldmann, a German engineer, recently made a thorough investigation, described in the "Elektratechnische Zeitschrift," in which he found that the claims were substantiated, that over-compounding is also possible and, what may seem surprising, there was no appreciable sparking under the third brush; this brush was made of carbon. The regulation may be changed from constant voltage to over-compounding by a slight movement of this extra brush.

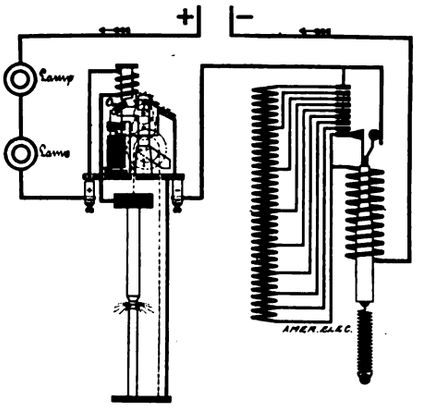
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**Increasing the Torque and Maximum Load of three Phase Motors.**—In an interesting paper by Mr. Marcher, in the "Elektrotechnische Zeitschrift," he shows that with the same iron framework the starting torque, the maximum torque and the maximum load which will cause the motor to stop, are greatly increased by diminishing the impedance. He shows this analytically and then proves it in actual cases. By merely changing the number of windings on the stator in the ratio of four to three he found that the impedance at no load had diminished to about a half; that the best efficiency and power factor was then at about double the overload and that the maximum torque rose in about the same proportion as the impedance was diminished. The load which would cause the motor to stop was 3.8 times as great, and the motor would start with five times the load at the normal speed and load. The exciting current and that at no load, however, was increased at the same rate at which the impedance was diminished. Curves indicating how the output and torque varied with the current, showed that for the same current both these were increased to about double their former value. He also shows that adding resistance in the stator circuit of a short circuited motor for starting purposes, and the increasing of the air space, are both very poor methods.

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**Arc Lamps on Incandescent Circuits.**—When arc lamps are run on constant potential circuits, such as those used for incandescent lamps, it is always necessary to insert a dead resistance in series with them. The reason for this is that most arc lamps regulate by the action of a shunt coil, the potential at the terminals of which varies for different currents; if it were not for the dead resistance this voltage would remain constant, as they are connected to constant potential mains; the dead resistance is therefore necessary to produce a variation in the voltage with the current in order to bring about regulation. Many attempts have been made to do away with this resistance, as it wastes about 25 to 30 per cent. of the energy in a circuit in which two arc lamps are connected in a series across 110-volt mains. It seems now that this important problem has been solved practically by means of a differential arc lamp which has been in satisfactory use to a large extent for some months in Berlin. With these lamps practically no such dead resistance is required, and therefore the energy is more fully utilized, with the great advantage that three lamps instead of two may then be connected in series across 110-volt mains. As will be remembered, a differential lamp is one in which the regulation is effected by both a shunt and a series coil, and any variations in the current irrespective of those of voltage, are then also used to operate the regulating apparatus.

A diagram of this lamp is shown in the adjoining illustration, in which three lamps are shown in series, of which one is represented with all the connections. It will be seen that the regulation is effected by both a series and a shunt coil and that there is, in addition, on the right,




A CONSTANT POTENTIAL ARC LAMP REGULATOR.

a dead resistance, which, however, is used only for starting, and is cut out by a movable core in the solenoid through which the main current passes; the resistance is therefore only in circuit momentarily, to prevent great current rushes. By using three such lamps in series instead of two of the ordinary form, the amount of light produced is increased in the ratio of about three to four; a room formerly requiring 12 lamps will then be equally well lit as far as the amount of light is concerned, by nine of the differential lamps, and, besides this, the amount of energy required will be less. When five or six lamps are connected across 220 volts instead of four, the increase of light is about 25 per cent. In that case it is better to use a dead resistance in each series, but merely for starting the lamps.

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**Brushes Made of Alloys.**—Various alloys have been suggested for the material of brushes with the object of combining conductivity with as little friction as possible. The following alloys suggested by Boudreaux in the "Elektrochemische Zeitschrift" may be of interest. An alloy is made of copper with 0.20 per cent of bismuth, 0.30 per cent. of cadmium and 1.50 per cent. of antimony. These proportions may be varied depending on the purpose for which the brush is to be used; the quantity of the ingredients should be doubled, for instance, if the commutator is of a hard bronze—like copper alloy, and to be tripled if of steel. Copper brushes are said to generate much more heat by friction than brushes made of these alloys. The metals may either be melted together, as usual, or they may be mixed as fine powders and then compressed together, with the aid of heat, into the desired form and consistency.

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**Interior Illumination.**—In many measurements of the loss of light due to the globes around arc lights, the amount of light given off in a definite direction is measured both with and without globes. It is evident, however, that this is not correct, and would give results which are far from the real ones. The globe diffuses the light so that most of it is not sent in one particular direction, as in the case of the bare arc. The only proper way to obtain the real loss in a globe is to measure the total spherical illumination in both cases and then compare the means. This was done by Mr. Utzinger, who found that the means in the two cases were 320 and 360, with and without the ordinary glass globe, but whether it was a milk glass or ground glass globe is unfortunately not stated. These figures show that the real loss is only 11 per cent., and not 30 per cent., as has often been stated. In a recent paper by him, reprinted in the "Zeitschrift fuer Beleuchtungswesen," he gives these results as well as some others which may be of use in determining the amount and distribution of light for interior illuminations. When the greatest possible uniformity in illumination is required he recommends using a white reflector below the lamp, reflecting all the light against the ceiling, from which the room is then illuminated. Usually in this method the arc is inverted; that is, the positive carbon is made the lower, so that most of the light will fall on the ceiling without reflection, but this, he says, produces an unsteady light, owing to the fact that parts of the carbon and impurities fall into the crater; he therefore seems to recommend making the upper carbon the positive, as usual, even though this involves a greater loss. This method of reflection on to the ceiling is also recommended in the case of enclosed arcs in which the arc is apt to wander from one side to the other, and by reflecting it all onto the ceiling the inequalities in the light are reduced. In this way even greater uniformity may be obtained in interiors than by daylight through windows. The following figures will give a good idea of the illumination obtained. The dimensions of the room were 13.6x7.10 x 3.5 meters high and there were two direct current open arcs of 12 amperes, with a reflector beneath, reflecting all the light to the ceiling, which presumably was white. The mean illumination was 66.5 meter candles and the variations were

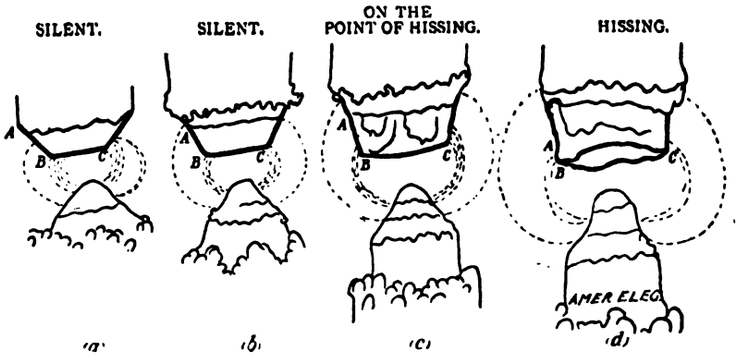
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only 25 per cent. above and below this. Daylight illumination gave 12 times this, but it is said that with 50-meter candles it is quite as easy to read as in daylight, while 10-meter candles is said to be the hygienic minimum. (A meter candle is the illumination produced by one candle at the distance of one meter.) The loss of light in this double reflection method is 35 to 40 per cent., but as globes would otherwise have to be used, it is really only 20 to 30 per cent. as compared with the usual arcs in globes. Practically, however, there is no difference in the amount of energy required, for the reason that when the illumination is uniform a less intense illumination is quite sufficient. When alternating current lamps are used in this way about one-third more energy is said to be required.

**Filament of Carbide of Silicon.**—The efficiency of an incandescent lamp, as is well known, depends on the temperature to which the carbon can be raised without too rapid deterioration; the higher this temperature the better the efficiency. It is therefore very desirable to discover some material which can stand a higher temperature than carbon. According to reports published in the English papers, such a material has been found in the form of a carbide of silicon from which lamp filaments are now being made for what is known as the "Premier" lamp. Liquid cellulose is mixed with powdered silicon and is made into threads which are carbonized at a very high temperature so as to cause the carbon and silicon to combine, and after the filaments are ready they are flashed, or treated, as it is commonly called, in a vapor of silicon and carbon, a process analagous to the usual treatment in hydrocarbon gases. It seems that such filaments also have the good property of not falling off in light or blackening the bulbs appreciably. According to a report by Prof. Ayrton such a lamp started at an efficiency of 2.8 watts per amyl-acetate candle, and ran for 600 to 800 hours without any material decrease in the light or efficiency and without causing blackening of the bulbs. This improvement is said to involve a saving of about 25 per cent. of the lighting bills, assuming, we presume, that the cost of the lamp and the price of the energy per kilowatt remains the same.

**The Hissing Arc.**—Those who have worked with arc lights have, no doubt, been greatly annoyed with the hissing state into which arcs are apt to fall. In a recent paper reprinted in the English electrical journals Mrs. Ayrton, with her usual thoroughness, describes very careful researches made with hissing arcs, the results of which will be of assistance to those working with arcs. For each length of arc she found that the voltage diminishes as the current increases, up to a certain point, when the arc suddenly becomes very unstable and then passes to the hissing stage when the current is further increased; for this stage, however, the voltage remains practically constant for all further increases of the current, meaning by voltage the difference of potential between the carbons. Among other things she shows the following: A silent arc may be made to hiss by increasing the current sufficiently; the largest current for a silent arc is greater the longer the arc; when the arc begins to hiss the voltage falls about 10 volts and the current suddenly rises two to three amperes; when the current is constant and the arc silent, it will hiss when shortened; and, finally, for the hissing arc the voltage is constant for any given length of arc, whatever the current. It was also shown that the largest current that would flow silently with any given length of arc was increased by using thicker carbons. For hissing arcs the voltage is the same for any given length of arc whether the carbons are cored or solid. There is a maximum value of the current for each pair of the carbons for sustaining a normal silent arc, and any currents greater than this will cause hissing, no matter what the length of the arc is. There is a straight line law connecting the voltage with the length of the arc, both with hissing and with silent arcs. Hissing will start only when the current is greater than it can be with any silent arc of the same length. The longer the arc the less will the voltage diminish in changing from silence to hissing. The smallest hissing current depends in a measure, also, on the voltage of the generator.

She also made an elaborate study of the form and appearance of the ends of the carbons in the normal and the hissing arcs, and found that the whole appearance of the crater changes with hissing; the chief change is in the positive carbon, in which the crater becomes larger while hissing, and extends up around the edges, or, in other words, in the hissing arc the crater becomes so great that it extends up around the sides, overflowing, as it were. Some idea of the appearance of the arc is shown in the adjoining illustration, in which the arc was kept at 2 mm. and the currents were 6, 12, 20 and 30 amperes, respectively, beginning at the left-hand side. The first and second arcs were silent, the third was at the point of hissing and the fourth was hissing; the extension of the crater, however, is not very clearly shown in these; but it will be seen how the positive carbon loses its point and becomes more cylindrical. When, therefore, the crater occupies only the end of the positive carbon, the arc is silent, but when it also extends up the side the arc will hiss; the crater, of course, becomes larger as the current increases. All these experiments refer to arcs which have been running for a long enough time to have all the conditions adjust themselves to that particular form of arc. By keeping the same length of arc and gradually increasing the current, a hissing point will always be reached. Moreover, the longer the arc the greater must be the area of the crater and consequently the greater the current before it extends up the side of the carbon; hence the longer the arc the greater will be the silent current. The thicker the positive carbon the greater is the largest silent current for any particular length of arc. She found, furthermore, that the actual cause of the hissing was due to the oxygen getting at the carbon and thus burning it instead of volatilizing it.




THE ARC IN VARIOUS CONDITIONS.

**Mechanical Traction in Paris.**—At the end of the last year there were not less than 31 lines in Paris on which 12 different systems of mechanical traction were used, six of which systems, or 13 lines, were electrical. Six of these are operated with accumulators, while the rest are overhead, conduit, surface contact or combinations of these. Paris is evidently going about it in the best way to find out for itself which is the best system. It is an expensive and slow process, but it is a safe one.

**Automobiles.**—At the end of a long series of articles discussing the various forms of automobiles, a Frenchman, Mr. Lavergne, compares the various kinds of power and concludes that steam will be used for general transportation, petroleum for touring, and electricity for the service in cities.

**A Proposed Electric Railway Up Mt. Blanc.**—Electric traction has simplified the problem of mountain railways so greatly that lines which were heretofore impossible, or at least impracticable, are now quite within the limits, and become merely a question of cost rather than one of surmounting engineering difficulties. That bold project, the line up the Jungfrau, in the Alps, which is now under

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construction, has given rise to projects for ascending Mt. Blanc by an electric line. Most of these projects are rather illusionary, one of them, for instance, being to bore nearly horizontally into a mountain to a point below the top, and then ascending by means of an elevator and a vertical shaft. Recently a new and more reasonable project has been worked out by a Frenchman named Fabre, a brief description of which is given in "L'Electricien." The idea is to tunnel just below a ridge which extends along the side of the mountain, thereby avoiding the glaciers, which, of course, cannot be pierced, as they flow, and would have to be avoided by going under them, which is expensive; the glaciers, of course, do not pass over these ridges and are thereby avoided. Owing to the very high altitude, the workers will have to live on the mountain in building the upper end of the line, so as to get accustomed to the rarified atmosphere, and all material for that part of the road must be carried up; the lower end of the line will therefore have to be constructed first, and it would take a long time to complete. As the top of the mountain is a large mass of ice, it is impracticable to have a station there, but there is a convenient spot on a promontory, about 800 feet lower, to which it is proposed to run the line. The total length will be about 6 miles. It will be a rack and pinion line driven electrically, the power being generated by a neighboring waterfall. The total cost is estimated to be about two million dollars.

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**Express Trolley Service in Germany.**—What is said to be the first express line operated in Europe was recently started between Duesseldorf and Crefeld in Germany. The speeds obtained, which are from 33 to 36 miles per hour, are not very high according to American ideas, all the more so as the average is only about 24, but in Europe, especially with an electric line, this is considered quite a high speed. The distance is only 12 miles and a trip with one intermediate stop is made in half an hour, a car running every hour. Instead of the trolley wheel, the well-known contact bar, which is used so frequently in Europe, is used. A novelty consists in the use of two trolley wires, presumably to assure better contact and avoid arcing. There is only one motor on the car and that is a gearless one of 40 h. p., the idea being to avoid the disagreeable noises due to the gearing. These data are taken from a very brief description in "L'Electricien."

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**Electricity from Refuse.**—There has been considerable discussion and experimenting in England concerning the generation of electrical energy for a city, using as a source of power the city refuse, which must be disposed of, and includes ashes, garbage, sweepings, etc. Perhaps one of the best indications that such a system is not only promising, but is doubtless a success, is the fact that it has just been decided to erect a large plant of this kind for the Hackney Vestry on the recommendation of a very noted English engineer, Mr. Hammond. The plant can hardly be considered an experimental one, as the cost will be over a million dollars, and to start with two units of 1000 h. p. each are to be installed. Whether or not the statement made some years ago by a noted English scientist is true, that there is enough energy in the refuse of a city to light the whole city, remains to be seen, but that there is considerable energy in it seems assured. Such a plant, of course, must be credited with the expense which would be otherwise encountered in disposing of the refuse. It does not follow, however, that if such a plant is successful in England it would be so here, as the nature of the refuse seems to be quite different. The English, for instance, do not eat watermelons as freely as we do, and these, together with many other vegetables constituting our garbage, do not even contain enough energy to evaporate the moisture in them.

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**How to Balance an Armature.**—As is well known, high speed armatures must be carefully balanced or they will produce vibrations; a crude, but a very common way, of finding out whether an armature is balanced is the usual method of laying it on two horizontal rails, when an unbalanced excessive weight will cause it to revolve. Mr. Hill, in the London "Electrical Review" shows by calculation and measurements how very unsatisfactory this method is, as an excess of weight by no means too small to be negligible, it not sufficient to produce movement when thus tested, or at least only when it is near the right or left-hand sides, where its leverage is the greatest. In a 16.5-inch armature, for instance, weighing somewhat over a thousand pounds and intended to run at 750 revolutions, he assumes that there is an excess of weight of about two pounds at the periphery on one side, and he find that this will produce a movement in the test, only when the excess of weight is within a comparatively small angle above or below the horizontal line. If not balanced, this weight is sufficient to produce a centrifugal force of 263 pounds, which would be sufficient to cause considerable vibration. He prefers mounting the armature on bearings, which are free to move, then driving it and finding the location of the excessive weight by means of a piece of chalk held near the revolving armature.

# The General Electric Company's Annual Report.

The seventh annual report of the General Electric Company for the year ending January 31st, 1899, was issued April 26th in anticipation of the coming annual meeting of the stockholders at Schenectady, May 9th.

The report of the First Vice-President, Eugene Griffin, covering the sales department, announces total sales as billed to customers amounting to $15,679,430, with a calculated direct profit of $2,584,896, the increase in orders amounting to 21 per cent. The orders received during the year amounted to $17,431,327, as against $14,382,342 for the previous year. Eight million four hundred thousand incandescent lamps were ordered during the year.

The report of the Third Vice-President, E. W. Rice, Jr., covering the manufacturing department, noted particularly the increase in the company's facilities. Among the additions to the works are the large iron foundry at Schenectady, described in the last issue of "The American Electrician"; the brick and steel machine shop, covering 3¼ acres, which is now being equipped with the necessary machinery, and extensions amounting to about 40,000 sq. ft. to other existing buildings in Schenectady.

At the Lynn Works the capacity of the steel foundry has been increased 40 per cent. A new building is now under way for the manufacture of meters and instru-

CONSOLIDATED PROFIT AND LOSS ACCOUNT OF JANUARY 31, 1899.

| DR. | | CR. | |
|---|---|---|---|
| Balance January 31 1898 (deficit)... | $11,725,561 | Reduction of capital stock, August 17, 1898 | $13,884,800 |
| Reduction of book value of patents, franchises and good-will, June 30, 1898. | 4,000,000 | Balance carried down | 1,840,761 |
| | $15,725,561 | | $15,725,561 |
| Balance brought down (deficit) | $1,840,761 | Sales, royalties and sundry profits | $16,472,022 |
| Cost of goods sold | 13,094,534 | Dividends and interest received on stocks and bonds owned | 342,000 |
| Patents and patent expenses | 269 440 | Interest and discount | 119.953 |
| Interest on debentures | 290,000 | Profit on sales of stocks and bonds | 324,462 |
| Dividends on preferred stock | 1,609.552 | Discount on debentures purchased and canceled | 2,422 |
| Balance January 31, 1899 (surplus) | 156,571 | | |
| | $17.260,858 | | $17,260,859 |

CONSOLIDATED BALANCE SHEET OF JANUARY 31, 1899.

| ASSETS. | | LIABILITIES. | | |
|---|---|---|---|---|
| Patents, franchises and good-will | $4,000,000 | Capital stock: | | |
| Factory plants and real estate | 4,015,035 | 7% Cumulative preferred | $2.551,200 | |
| Stocks and bonds | 7.226,422 | Common | 18,276,000— | $20,827,200 |
| Cash | 1,456,793 | 5% Gold coupon debentures | | 20,827,200 |
| Accounts receivable and work in progress | 5.594,016 | Accrued interest on debentures | $47,50044 | |
| Inventories | 4,882,238 | Accounts payable | 431,496 | |
| | | Unclaimed dividends | 11,739— | 490.735 |
| | | Profit and Loss | | 156,570 |
| | $27,174,506 | | | $27,174,506 |

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ments with an area of 35,000 sq. ft. At the Harrison Works a new building containing about 60,000 sq. ft. will be completed this summer.

The area of the factory buildings now in use aggregates about 1,800,000 sq. ft. (41.3 acres enclosed) and the number of employees now at work is 9,000. The cost of additions during the year amounted to $387,353, and that of machinery practically $400,000, all of which was charged against the general earnings of the company, as were expenses for maintenance and repair, plus an allowance to provide for depreciation.

The report of the Second Vice-President, J. P. Ord, covering the finances of the company, is summarized in the accompanying balance sheet and statement of profit and loss. By vote of the directors there was charged to profit and loss on June 30, 1898, half the book value of patents, franchises and good will, or $4,000,000. There has since been written off the expenditures during the year in acquiring new patents and patent liquidations, $269,440, leaving the patents, etc., standing on the books as at the time of the previous report of $4,000,000. The book value of the plants also remains the same as at the time of previous reports, additions as above mentioned having been charged against profit and loss.

During the year the valuation of both common and preferred stock has been reduced 40 per cent. All the accrued dividends on the accumulative preferred stock from July 1st, 1893, to January 31st, 1899, were charged off against the surplus, leaving the latter at the figure of $156,571, as against a deficit of $1,840,761 at the beginning of the year. Following the policy of the last few years, the company has no notes payable, nor is there under discount any paper bearing the company's endorsement or guarantee. Sales have been maintained on the basis of short credit to desirable customers and all purchases have been paid for in cash. The company has not borrowed any money, but, on the contrary, has bought $300,000 of the $6,000,000 of its outstanding debentures.

## NOTES.

**Automobile Artillery.** — An English cycle corps is about to experiment with an electrical motor tricycle, carrying a Maxim rapid-fire gun, the weight of the gun and carriage being only 140 pounds.

**The Nernst Lamp in Practical Use.**— Negotiations are now progressing for a trial of the Nernst lamp for street lighting in Berlin, Germany. It is proposed to light some of the avenues in the Thier-Garten district by this means.

**Honor to Volta,**—The telegraph operators of Italy have asked for subscriptions from operators the world over for the purchase of a bronze crown to be placed at the foot of the statue of Volta in Como, Italy, at the time of the celebration, this month, of the hundredth anniversary of Volta's discovery of the primary cell.

**Inspection Trips of Electrical Students.** —The electrical engineers of the senior class of the Worcester Polytechnic Institute this year visit the following places: The Stanley Works at Pittsfield, Mass.; the power transmission plant at Mechanicville, N. Y., and the works of the General Electric Company at Schenectady.

**The Convention of the Southwestern Gas and Electric Street Railway Association,** which was planned for April 19th, has been postponed to May 17th on account of the prevalence of smallpox in the Southwest. It will eventually be held in Austin, Texas, and an electrical exposition will be held in connection with it.

**A Motor Carriage Exhibition at Berlin.** —During the month of September, 1899, there will be held at Berlin an international competitive exhibition of automobiles and motors and accumulators therefor. A progressive series of tests, races, etc., will be held in connection with the exhibition.

**Municipal Ownership of Street Railways in Detroit.**—By a bill recently passed in the State Legislature of Michigan, a commission of three, among them Gov. Pingree, has been appointed to buy for the city 180 miles of street railway in Detroit, now owned by Messrs. R. T. Wilson and Tom Johnson, as well as any suburban lines that they may choose.

**Power Transmission for Irrigation.** — For the lifting of water from artesian wells for irrigation purposes in Southern California, there is often required considerable power, which, because of the high cost of fuel, makes the wells valueless. The Mt. Witney Power Company of Visalia, Cal., has ordered a power transmission plant with a generating capacity of 1800 horse power, which will distribute power to five sub-stations in five separate towns, the power being largely used for pumping purposes.

**Central Station Development in Brussels.**—The municipal electric lighting system in Brussels, according to a consular report, is to install five new vertical engines of 1000 h. p. each. The city owns two plants, which are to be connected apparently by trunk feeders. It was proposed to erect a large central generating station outside the city limits, but this plan has been abandoned in favor of separate stations nearer the centers of distribution.

**Railroad Rates to the Coming Electric Light Convention.**—The Trunk Line Association has granted a rate of a fare and one-third, on the certificate plan, from all points in their territory and return, for delegates and friends attending the twenty-second convention of the National Electric Light Association, to be held in New York, May 23, 24, 25. It is expected that the same rate will be granted by the other railway associations at an early date.

**A Vertical Headlight Ray.**—Experiments have been made on a locomotive running between Cincinnati and Indianapolis with an electric headlight fitted with a mirror which deflects upward part of the rays issuing from the light. It is claimed that this beam is visible from a great distance and gives an indication of the approach of a locomotive often before the ray sent straight ahead is seen.

**Electric Vehicle Interests in Chicago.**— Mr. Samuel Insull, President of the Chicago Edison Company, has organized and is president of the Woods Moto-Vehicle Company, which will absorb the Fischer Equipment Company of Chicago and build self-propelled vehicles for business and pleasure, under the patents of C. E. Wood. The authorized capital is $10,000,000. It is said that the company will be closely affiliated with the Chicago Electric Vehicle Company, the incorporators of which are interested in the Chicago Edison Company.

**The Consolidation of Automobile Interests.**—A combination has been effected between the Pope Manufacturing Company and the Electric Vehicle Company, and through the latter with the Electric Storage Battery Company, for the manufacture and running of automobiles. A company called the New Columbia Motor Carriage Company, with a capital of $3,000,000, has been formed to handle the work. Under the consolidation the construction work will be carried on at the works of the Pope Company in Hartford, the batteries will be, as before, made by the Electric Storage Battery Company of Philadelphia, and the numerous sub-companies, which the Electric Vehicle Company, as a parent concern, has established throughout the country, will exploit and use the completed products.

**The Training of New York Motormen.** —The Metropolitan Street Railway Company of New York has a training school for the men who run the cars on its extensive underground trolley lines through the busy streets of New York City. The school occupies a loft in the car barns at 7th Avenue and 50th Street, equipped with dummy car platforms and their usual appurtenances. Here the men are taught the elementary steps in car control, as well as the rules and considerable information on car construction, wiring, details, etc. Three days are given to this kind of instruction, after which the student is sent out on a car with one of the old hands and only allowed to take a car alone after about three weeks of training. A sort of post-graduate course of lectures is given on Friday evenings.

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**Exhibitions in Philadelphia.**—The Philadelphia Bourse has established an Industrial Exposition partly in the basement and partly on the 7th floor of the Bourse Building, the total space occupied amounting to 54,000 sq. feet. The exposition department hopes to get a great many of the exhibitors in the coming electrical show in New York to remove their exhibits permanently to this exhibition. The Philadelphia Commercial Museum and the Franklin Institute have also organized the Philadelphia Exposition, which will be held from Sept. 14th to Nov. 30th, 1899, on a tract of land 56 acres in extent on the west bank of the Schuylkill River. The buildings are so connected as to constitute one grand structure some 400x900 feet in extreme dimensions, inclusive of court yards.

**An Automobile Carrying Its Own Generating Station.**—A heavy motor truck for freight work in city streets has been built by the Fischer Equipment Company of Chicago on the general principle hitherto developed in the Patton motor car. Power is derived from a 3-cylinder 8 h. p. vertical gasoline engine located in the forward part of the truck under the driver's seat; this is direct coupled to a dynamo which charges a battery of 40 cells of 144 ampere hours capacity. The dynamo and storage battery in turn supply the two 5 h. p. motors geared to the rear wheels. The engine is kept in continuous operation while on the road, charging the battery when the motors take a small current or none at all, supplying the motors direct when the load is moderate, and being helped out by the battery at times of heavy load. The weight of the truck is 9000 pounds.

**Increased Demand for Power Transmission in Sacramento.**—The Sacramento Electric Gas and Railway Company, which is now transmitting 4000 h. p. from Folsom to Sacramento, is about to add the fifth 1000 h. p. unit, for which its works were planned, which will only partially supply the increasing demand at the receiving end of its system. On this account it has contracted with the Yuba Electric Power Company for 5000 h. p. more. The Yuba company now operates 1,500 h. p., furnishing current to various other points. The new plant will be constructed with a capacity of 15,000 h. p. The present dam will be enlarged, a new timber flume 8½ miles long, 7 feet wide and 5½ feet deep will be built with a grade of 12.8 feet per mile. An insurance reservoir will be constructed at the forebay with a capacity sufficient to furnish 10,000 h. p. for six days continuously at the normal head, which will be 688 feet. The overhead line to Sacramento will be of aluminum wire worked at 40,000 volts pressure.

**The Telegraphic Transmission of Pictures.**—Several prominent newspapers have put into experimental use the instrument called the Telediagraph, developed by Mr. E. A. Hummell of St. Paul, Minnesota, for the transmission of line drawings telegraphically. On April 19th newspapers in the following places: St. Louis, Chicago, Philadelphia, Boston and New York, exchanged photographs and other pictures with apparent success, judging by the reproductions in their columns. The principle of the instrument is as follows: A tin foil sheet is marked in an insulating ink with the design to be transmitted and wrapped around a cylinder. The cylinder is rotated under a contact, which is run along the cylinder by a screw much as is the needle of a phonograph, the marked portions of the tin foil making and breaking the circuit as the contact passes over them. At the receiving end is a similar cylinder wrapped with paper and a carbon manifolding sheet and kept in sylchronous rotation with that at the transmitting end. The incoming currents affect a stylus, which records upon the paper marks corresponding to the raised portions of the tin foil at the transmitting end.

**Rapid Transit in New York City.**—The spirits of all New Yorkers who hoped to see a satisfactory rapid transit system up and down Manhattan Island were raised during the last of March by the offer of the Metropolitan Street Railway Company to construct a tunnel which the Rapid Transit Commission has for so many years been attempting to get under way, either with public or private ownership. The Metropolitan's plan proposed several improvements not previously considered, notably the connection of the tunnel to the surface at various points for the running of through cars from the existing street lines into the tunnel and vice versa. The company's proposition, however, was a little too selfish for the approval of those supposed to look out for the best interests of the community, and objections were raised to the perpetual franchise, the free use of the tunnel as a subway and other features of the proposition, which caused the company to withdraw its offer on April 17, evidently in the hope that the extreme need of rapid transit would force the city to grant it these rights in due time. The course of the struggle will be an interesting one to watch, as the franchise will be the most valuable ever granted by any city the world over. In the meantime the State Legislature has passed a new rapid transit bill, providing for private ownership of the tunnel with a franchise limited to fifty years. The Metropolitan Company refuses to consider this and there are rumors that the Manhattan Elevated Railroad Company will bid for the undertaking. Efforts are also being made to have part of the municipal indebtedness charged against the county, which would allow the city to build the road without exceeding the constitutional debt limit. One of the daily papers has even started a popular subscription list and obtained nominal subscriptions for stock to the extent of about twenty millions of dollars.

**Progress of Traction Consolidation in Brooklyn.**—Another step has been made during the month of April in the consolidation of the traction interests of the Borough of Brooklyn, New York City. The Brooklyn Rapid Transit Company, which already controlled the Brooklyn Heights and the Brooklyn Queens County & Suburban Railroad, and had acquired the greater part of the stock of the Nassau Electric Railroad, contracted with the reorganization committee of the Kings County Elevated Railroad and the Fulton Elevated Railroad Company to acquire the properties, privileges and franchises of these companies in exchange for $2,000,000 of the stock of the Rapid Transit Company. With one of these the Transit Company gets still another route on private right of way to Coney Island. viz., the Brooklyn and Brighton Beach Railroad, and has begun work equipping it with electric traction apparatus. The Transit Company has also contracted with the Long Island Railroad Company to lease for a period of 999 years the Prospect Park & Coney Island Railroad, the New York & Coney Island Railroad and the Prospect Park & South Brooklyn Railroad, and made a traffic arrangement with the Long Island Company whereby the through steam trains of the latter may be run over the local elevated tracks in Brooklyn. The one company now controls 85 per cent. of the surface mileage and all of the elevated mileage in the city of Brooklyn, including practically all of the available routes to Coney Island. The one independent surface company, viz., the Coney Island & Brooklyn Railroad Company, it is expected will join the consolidated interests in the course of a short time.

**Foreign Visitors in America.**—During the month of April several British engineers visited the United States on tours of inspection of electric railway work. Among them was Prof. A. B. W. Kennedy, one of the most prominent of British electrical engineers, who is consulting engineer for tne London County Council with special reference as to whether or not the underground electric conduit system is practicable for the conditions found in London. Prof. Kennedy, in pursuance of this investigation, visited New York, Hartford, Boston, Schenectady, Buffalo, Niagara Falls, Chicago, Pittsburg, Washington, Baltimore and Philadelphia, on a flying trip extending over but two weeks, and at its conclusion expressed himself as very much interested in what he had seen. Accompanying Prof. Kennedy was E. W. Monkhouse, an electrical engineer of London, who desired to make a careful investigation of electric railway practice in this country in behalf of other clients. On April 13, Dr. Edward Hopkinson, managing director of Mather & Platt, Ltd., and Bertram Hopkinson, nephew of the late Dr. John Hopkinson, arrived in New York, and are now making similar investigations in various cities of the United States with a view to acquiring a general understanding of the best American practice in electric railroading. They expect to return in May.

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### The Electrical Exhibition—Greeting.

Ever since the dawn of civilization one of the greatest institutions of instruction and entertainment has been the gathering together for public inspection of the products of man's handiwork. In modern times it takes various forms, from the primitive county fair and the oriental market, through the permanent exhibitions and perhaps the department store, to the great international expositions. With the increasing specialization of industry and consequently of interest, specialized expositions are coming into existence, and one of the most sturdy and promising of these is the electrical exhibition of New York City, which promises to rival in regularity of occurrence and extent of country from which it draws both exhibitors and visitors, such great affairs as the world famous Russian fair of Nijni Novgorod.

The third exhibition opens in Madison Square Garden on May 8th, and promises to be of even greater value to the engineer and interest to the layman than were its predecessors of 1898 and 1896. The fame of these has spread so widely that the electrical exhibition is now far from being local in character or patronage. Electrical engineers from all parts of the country make a point of timing their annual visit to New York City during the month of the electrical show, and this year the annual convention of the National Electric Light Association will bring its attendants to the Garden.

While this pilgrimage of the technical men is what makes the show of value to the exhibitors, the financial success of the exhibition company is dependent upon the popular interest in the more sensational and less scientific exhibits on the part of a large portion of the enormous population resident in the metropolitan district, in and about New York City. The special department of particular novelty and interest this year will certainly be that embracing the automobiles, which will be attractive to both the general public and the engineer. Second only to this will probably be the interest exhibited in wireless telegraphy, the possibilities of which during the last few weeks have excited the most intense attention in England.

### General Electric Finances

The annual report of the General Electric Company, an abstract of which will be found on another page, exhibits a remarkable game of battledore and shuttlecock with the profit and loss balance, the final outcome of which, combined with the healthy growth of its business and profits, should be most gratifying to the stockholders.

In the first place the 40 per cent. reduction of the valuation of the stock, removing from the column of liabilities $13,884,800, wiped out the profit and loss deficit which the company had struggled with for many years and had finally brought down to some $12,000,000. The surplus of $2,159,000 obtained by the capital reduction was immediately turned again into a deficit of $1,840,761 by the 50 per cent. reduction of the valuation of patents, franchises and good-will effected June 30th, 1898, which removed from the column of assets $4,000,000. The profits for the year, however, figured up to $3,896,884, as against about $2,000,000 during the previous year, covering this deficit and giving over $2,000,000 surplus, which was largely used in paying up the unpaid accrued dividends of some 30 per cent. on the 7 per cent. cumulative preferred stock up to Jan. 31st, 1899, leaving finally a small surplus of $156,570.

The reduction of the preferred capital by $1,700,000 means an annual gain to the benefit of the common stockholders of about $120,000, which, with the rapidly increasing business and the increasing ratio of profits to total business, should soon begin to give some dividend on the common stock. Altogether the report is a very flattering one, especially for a year in which there has been the industrial depression of an international complication, and the revival of activity which has already followed the war may be expected to combine with the improvements already manifested in General Electric finances to make a most flattering appearance next year.

### Gas Engines in Railway Power Plants.

It has been the common belief that the gas engine would prove an unsatisfactory prime mover for traction service, owing to its unsatisfactory operation with rapidly varying loads. There will be found on another page a description of a street railway plant where the load conditions are about as severe as might be imagined—a plant working from one to three cars, on a profile showing a heavy grade for about one-third of the length of the line.

To be sure, the power house is equipped with a storage battery, but this is used not to improve the regulation, but on account of the inherent inability of the gas engine to carry extreme overloads. The gas engine reaches its greatest economy at maximum load and is consequently rated as near this output as possible, a small allowance, generally 10 per cent., being given to insure that the engine will maintain full speed with varying qualities of gas, etc. Thus an engine which gives on test 55 or 56 h. p. would be rated at 50 h. p., and if given an overload of more than 10 per cent. would slow down and perhaps stop, while a 50 h. p. steam engine would easily stand a 25 per cent., or in the case of four-valve engines, a greater overload before it would be pulled up. To carry a load, therefore, with peaks running up to 100 h. p., for example, it

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would be necessary on the one hand to install at least a 90 h. p. gas engine, while on the other hand an 80 h. p. steam engine would do the work. With such a load the gas engine would be practically always working at a low percentage of its most efficient load and consequently at a poor economy, while the steam engine would be working with loads not much below that of maximum efficiency. The storage battery is therefore more necessary for a gas engine than for a steam engine with such a load as that described in the article referred to, but should undoubtedly, for best economy, be used with either.

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Besides the well-known fuel economy of the gas engine, as compared with the steam engine, particularly in small units, the former requires less space than the equivalent steam plant and may be run with considerably less attention, so that one man at a gas engine power house might attend to quite a large equipment, or in the case of a small equipment, might do considerable other work, besides simply attending to the plant. The first cost of a gas engine installed is about equal to that of the equivalent steam engine with boiler, pumps, piping, etc., installed, and the depreciation is no greater than that of the steam engine and certainly less than that of the boiler.

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**125-Cycle Transformers on 60-Cycle Circuits.**

Many central station engineers, contemplating the purchase of alternating-current dynamos of the now generally approved frequency for lighting work, viz., 60 cycles, hesitate on the score that they will be obliged to change all of their transformers and meters on their 125 or 133-cycle lines to suit the new periodicity. A slight knowledge of alternating currents confirms them in this fear. With a frequency one-half as great, they reason, the rate of change of lines of force on a given transformer will only be half as great, and the e. m. f. which that transformer will stand will therefore be reduced 50 per cent., so that putting 60 cycle current on to 125-cycle lines will have results as disastrous as the biblical putting of "new wine into old bottles," or, to be more precise, will burn the transformers out. As a matter of fact, there is but a trifling difference between two transformers designed for the same load, efficiency and regulation, for 60 and 120-cycle circuits respectively, and transformer manufacturers, as a rule, put out identically the same instrument for both uses. Many central stations regularly run circuits during part of the day on high frequency and the rest of the day on low-frequency machines.

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The behavior of a 120-cycle transformer with 60 cycle current, as compared with its action under the frequency for which it was designed, is as follows: The ratio of transformation is, of course, exactly the same, as are the copper losses and the eddy current losses in the iron. The 50 per cent. reduction of the frequency necessitates a doubling of the density of the alternating magnetism in the iron to maintain the same rate of change of lines of force, upon which depends the voltage. Transformers for 120 to 133 cycles are designed for a low density in order to keep down the iron losses, so that this doubling is easily attainable. It, however, increases materially the magnetizing or leakage current, making it three or four times as great as on the higher frequency. This reduces the power factor of the station output, particularly if there are a lot of small lightly loaded house to house transformers on the lines. However, on account of the reduced frequency, the inductive drop in the lines and machines does not increase in proportion to this increased lagging current. The doubling of the density multiplies the hysteresis loss per cycle by about 3, as the loss is proportional to the 1.6 power of the density. However, the number of cycles being reduced 50 per cent., the hysteresis loss is only really increased about 50 per cent. The regulation remains about the same.

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Care should be taken, however, in such a change, in the matter of meters. All recording ammeters or wattmeters of the induction type, such, for example, as the Shallenberger meter, will have their speed very materially reduced on the lower frequency, while meters of the type in which the motor is fitted with a commutator, such as the Thomson indicating wattmeter, will work with equal accuracy on any frequency.

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**Individual Motors vs. Group Driving.**

Now that electrical means have come to be generally accepted as the best for the distribution of power to numerous points of use in industrial establishments such as machine shops, printing offices, etc., one of the important problems is the division of the electric motor units. The chief losses of the shaft and belt system are eliminated by the use of a few large motors, each driving a number of closely grouped machines by means of the usual overhead shaft and cone pulley. The substitution for such a motor, shaft and pulley, of individual motors, one for each machine, increases greatly the cost and reduces the efficiency of the installation, as the smaller motors are more wasteful than the larger ones. It also increases considerably the aggregate h. p. capacity of motors required, as each individual motor must be capable of carrying the maximum load of machine it drives, while with the group arrangement these maxima never carry simultaneously, and the load curve of the group driving motor is correspondingly smoothed out.

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A discusion of this subject at a recent meeting of the American Institute of Electric Engineers brought out the general opinion that the efficiency, and within limits the first cost, of the installation are minor matters compared with many gains that might be called incidental, but overwhelmingly dictate the use of individual motors except in rare cases of very small units, etc. In a machine shop clear head room is of almost inestimable value for crane work, as it is in printing offices and similar establishments for clear lighting. Group driving, as ordinarily carried out with overhead shafting, obstructs the head room almost as much as does a complete belted system, so that individual motors are necessary to obtain these advantages.

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With rare exceptions the cost of the power in any industry involving power driven machines or machine tools seems to be between 1 and 5 per cent. of the total cost of the finished product, so that a reduction of the efficiency of power distribution by, say 25 per cent., amounts to a very small increase of the cost of the product of the works, which may be far more than made up by the increased effectiveness of that comparatively expensive element—labor, caused by such an apparently trivial improvement as better light, handier crane movement, readier speed control or increased flexibility of arrangement.

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Again, the improved appearance of a shop without belts has its effect on the neatness of the work of the operatives, especially if the material worked upon is easily soiled, as is paper. With oil dripping hangers, etc., gone, the walls may be painted white and the tools covered with aluminum paint and the quality of neatness and general "ship-shapeness" will readily find its way from the equipment to the work done.

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## HOW TO MAKE AND USE A PHOTOMETER.

BY PROF. ARTHUR J. ROWLAND.

The time has passed when an incandescent lamp is accepted as having the candle power marked on the label. It is a common thing to make tests of lamps from every barrel lot to see what they really are. The rating of a lamp by its watts per candle power is recognized as the only way to estimate its value, when new at least, and determinations of the true rating often precede and follow the award of large contracts.

That these values may be determined by lamp users there must be a means at their disposal for measuring candle power. So it is that a photometer, once considered an instrument solely for use in a physical laboratory, has come to be one found in many central stations and isolated plants. Within a couple of years past, commercial photometers have been made and offered for sale by most, if not all, the manufacturers of scientific apparatus. They have been devised to make photometer measurements reasonably simple, not requiring elaborate or expensive apparatus, and yet yielding results sufficiently accurate for the every-day work of the lighting plant in determining the c.p. of the lamps bought, and determining whether that of old lamps has fallen so low that they must no longer be continued in service, to say nothing of tests of c.p. variation through the life of lamps from different lamp factories in order to get a proper estimate of their relative worth. At the price such instruments are to be had it is doubtful whether it is worth while to make one. There is, however, a great satisfaction to many people in using an instrument they have themselves constructed.

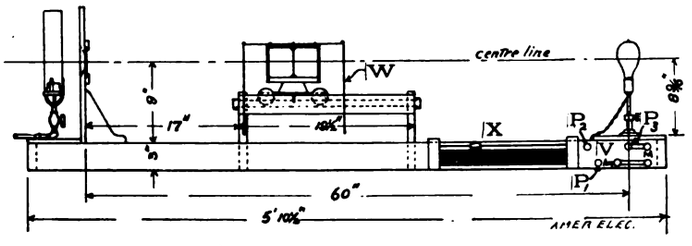



FIG. 1.—THE PHOTOMETER COMPLETE.

In the photometer here described, and for the construction and use of which directions are given, an attempt has been made to gather into one instrument the good points of a number, and at the same time to avoid their defects. In this an especial indebtedness is owed to a portable photometer made by the Newark Ornamental Iron & Sign Works, of Newark, N. J., which must be here acknowledged.

### CONSTRUCTION.

For the construction shown no materials are required which are not readily attainable at small cost, nor are there any processes of manufacture involved which are beyond the capabilities of a man with very simple tools and ordinary mechanical ability. In many things, some simple change might make a more finished instrument, but more machine work would be involved. Such modifications will eadily suggest themselves to anyone undertaking the construction.

A general drawing of the instrument is given in Fig. 1. The frame, which supports everything, is of ⅞-in. white pine 3 ins. wide, set together in an open rectangle 5 ft. 10½ in. long by 6¾ ins. wide over all. This frame may be supported at a convenient height by brackets on any side wall. At the left is an argand gas burner, in front of which is a board with an adjustable slot cut in it, the slot being directly in front of the argand flame. At the other end, on a suitable stand, is the incandescent lamp whose c.p. is to be measured. Between them is a frame on which travels a car containing a piece of paper set in a plane at right angles to a line joining the two lights. This paper has a grease spot on it, and in use the car is moved backward and forward until a place is found where the grease spot disappears. The c.p. of the lamp is then read off on a scale immediately below the car. For adjusting the e.m.f. on the lamp terminals a rheostat is provided, shown between the incandescent lamp and the track for the car at X in the drawing. The instrument is in principle a Bunsen photometer.

In Fig. 2 the car is shown in detail. The car proper is of wood, open in front, closed at the back, with ends cut away in openings 2½ ins. in diameter. Halfway between these two ends is the screen—seen in edge view at A. This is of two pieces of sheet metal (see D), about No. 14 or No. 15 B and S guage in both of which there is cut a circular hole 2 ins. in diameter. Between these pieces is put the paper with grease spot, as shown, and the two plates held together with small screws so the paper and grease spot can readily be renewed when necessary. The compound plate, D, slides in place from the front of the car in small wooden guides as at A.

To the right of the frame D in the figure is a section of the car taken halfway between the top and bottom. The two blocks F, F are wooden ones, extending from bottom to top of the car on which pieces of mirror are mounted. These mirrors should be of good quality, as near alike as possible and covering a large part of the surfaces G, so that an observer sees in each of them the reflection of the paper and grease spot—one side of the paper in one and the other side in the other. The exact angle at which these mirrors should be placed will best be determined in each case by trial. As shown, the results should be perfectly satisfactory. The piece B, between car proper and base, on which the wheels are mounted, is to be of lead. It may be cored out some, but is to give weight and stability to the car on the track and so must be heavy. The base to which wheels C are secured is of wood ⅞-in. thick and shaped to carry the lead block and three wheels as shown, two running on the forward track and one on the rear track. These wheels are simply porcelain insulators or knobs, which any central station will be likely to have in stock, or which may readily be procured from any dealer in electrical supplies. They run on wood screws as axles. If they are turned from iron or brass, B may be made of wood. The three parts making up the car are put together with two slender bolts passing down through all, from the car. E, in another part of the figure, shows a brass plate of about No. 12 or 14 guage, screwed to the top of the car and with light stiff wires (about No. 10) soldered to it and projecting forward. To each of these wires is hung a curtain of black drilling, 4½ or 5 ins. wide and 10 or 12 ins. long, hung as shown at W (Fig. 1). These curtains are to screen the eyes of the observer from the lights at the end of the bar. When this car is finished, it must be

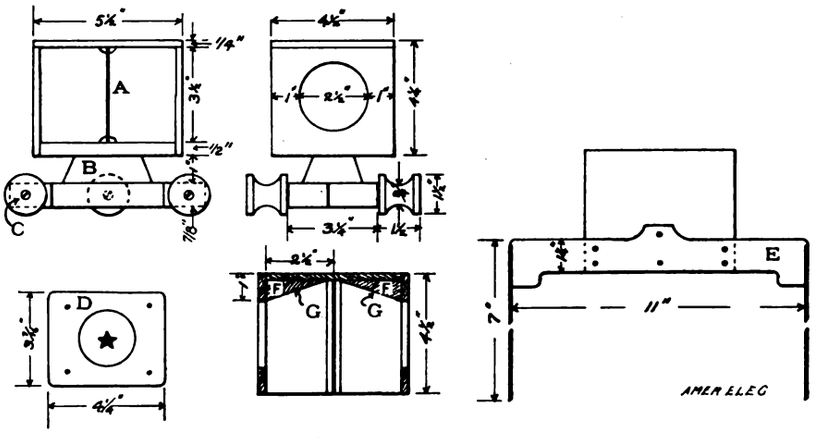
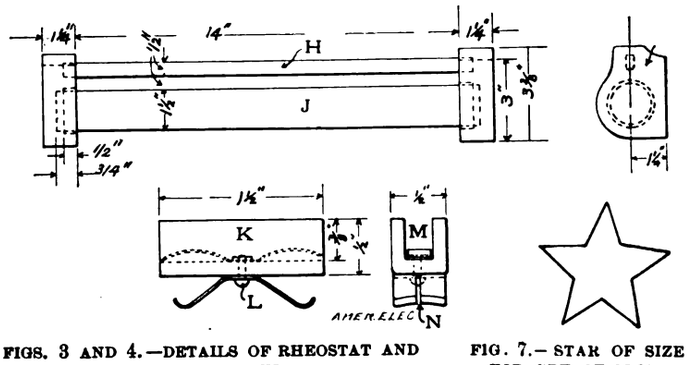



FIG. 2.—THE CAR IN DETAIL.

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painted black all over. Not a shiny black, but a dull, dead black, such as may be had at least cost probably by cutting a little lamp black with turpentine and adding just enough shellac varnish to make the black stick, but not get glossy.




FIGS. 3 AND 4.—DETAILS OF RHEOSTAT AND CONTACT MAKER.

Before taking up another part of the photometer, a few words as to methods of making the screen will be well put in. The sort of paper used is not of great importance. It must be white and quite nearly opaque. Preferably both sides should be as nearly alike as possible. The grease spot must be as transparent as possible, have a very clearly defined edge and the more edge the better. In Fig. 7 there is shown a star which is a good size to use and which has plenty of edge. To make the grease spot, cut the star out of brass plate (say ⅛-in. thick) and mount it on a rod set perpendicular to the plane of the star. Melt some paraffine over a water bath, put the star into the paraffine and let it warm some; then take it out, let it drain and set it down on the paper selected. A number of grease spots having been made, pick out the best for use. I have found a typewriter's paper, imitation linen, smooth, and rather thin, quite satisfactory—care being taken not to use any part containing a water mark.

The car runs on a track of which a satisfactory idea may be had from Figs. 1 and 6. The two tracks are of common ½-in. iron pipe, shown at P (Fig. 6), slipped through end pieces, whose form and size are shown in the same figure; and finished by iron caps screwed on each end. It will be necessary to pick out good smooth pieces of pipe for the purpose and perhaps do a little filing, so that in use one will not unconsciously tell by the "feel of the track" when the car is in some certain position along it. Q, in Fig. 6, is a strip of 7-16-in. wood which is in front of the pipe tracks in Fig. 1, and is to have the scale for reading c.p. mounted on it.

The framework must be mounted rigidly in place and the distances between it and the end fixtures, as well as the distances between them (the screen and the incandescent lamp) made exactly as shown. It is on the accuracy of these measurements that the value of the table given below, determining the c.p. scale, depends. The scale of c.p., to be mounted on the strip in front of the iron tracks as before mentioned, may be put on a piece of cardboard tacked to the board, the divisions laid out as per table below with waterproof india ink and then the whole shellacked over to preserve it and prevent weather changes from warping the cardboard out of shape.



FIG. 7.—STAR OF SIZE FOR GREASE SPOT.

The table is to read c.p. from eight to thirty. This is an abundant range for 16-c.p. lamps. Half candle powers may also be marked off by divided distances between marks on the scale, except for values when these are given in the table. A pointer is attached to the car directly under the greased paper (as per Fig. 1) by which to read car position and so c p.

At the left end of the frame is an argand gas burner (See Fig. 1). An oil lamp might replace the argand burner, but if gas is available it will be much more convenient to use. In the figure the argand burner is shown quite near the slot board; so near indeed that it is probable the board will have to be covered with asbestos paper on the side next it. To procure the results mentioned in Part II. it will be necessary to keep the burner up close. The exact position of the gas burner is not of importance except that it must be directly behind the slot when viewed from the car. The screen is shown in detail in Fig. 5. It is arranged with a slider to control the width of the slot S, which is 1 in. x 2 ins. at largest opening. If facilities are at hand it will be well to provide a screw and nut on the slider to control the width of the slot within small limits and readily. Bevel off the slot in fashion shown at R.

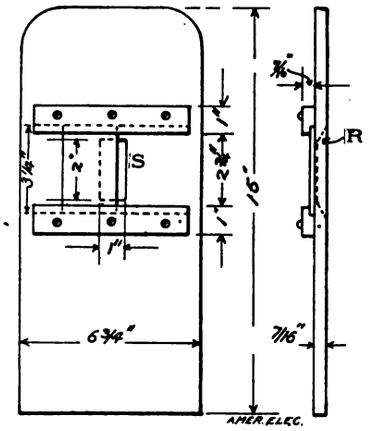



FIG. 5.—DETAILS OF SCREEN.

At the right hand end of the frame is the standard to hold the incandescent lamp, connection board and rheostat. An ordinary lamp socket has a ⅛-in. pipe screwed into it and this drops into a ⅜-in. pipe in a cast iron base through a ⅜-in. cap drilled at the end and with set-screw put through to hold the lamp rod at any height. The lamp cord is brought from the socket as shown and its ends carried to the two binding posts, $P_3$ and $P_4$, respectively. The mains are connected to the binding posts at M (Fig. 1), voltmeter at posts between which the letter V is put, and ammeter, if used, at posts on each side of Am, as marked. Otherwise this ammeter gap is bridged by a copper link. Two connecting straps are shown on the face of the frame and other connections are completed inside so that the circuit is from one post at M to $P_4$, then through the lamp to $P_3$, to brass rod marked H (Fig. 3), through the contact into the rheostat coil, then to P, and so out at the other side of connections for the mains. The voltmeter connected thus reads e.m.f. on the lamp terminals and the ammeter, both the current through the lamp and voltmeter, so that if this latter takes appreciable current, as it usually does, allowance must be made, unless the voltmeter is always off circuit when the ammeter reading is taken.

For the rheostat construction see Figs. 3 and 4. J is a round wooden core which, with end pieces, is preferably made of hard wood. Over J is a thin covering of asbestos paper, put on smooth and tight, and shellacked to place. Over 14¾ ins. of length at the middle of the rod is wound a tight spiral of No. 20 German silver double cotton covered wire also shellacked to place. This coil may be secured at its ends by tieing it down as with an armature coil or by soldering together the last two or three turns at each end. Along one side of the cylinder so formed, after the shellac has dried, and under the brass rod H (¼-in. thick x ½-in. wide), the insulation on the outside is to be rubbed off with sandpaper, making a path over the bared wire, ⅝ or ¾ ins. wide. This leaves each turn insulated from its neighbors, but makes it possible to connect readily with any turn of the solenoid. Bridging the distance from H to the wire on J, and making the contact just mentioned, is the contact device of Fig. 4. This is a brass body K, cut from ½-in. square rod, with an opening M, which rides easily on the rod H. Secured to it are German silver springs, as shown within, to make contact

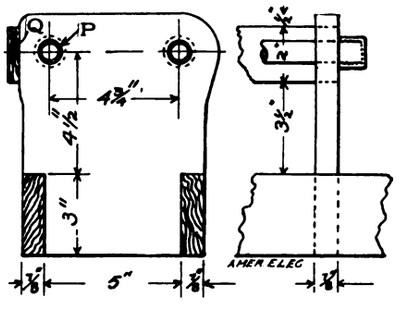



FIGURE 6

FIG. 6.—DETAIL OF TRACK AND SCALE ARRANGEMENT.

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with the rod, and outside to make contact with the turns of wire on the coil. A bolt like that at L can be had from almost any old lamp socket. It had better be very securely put in place. As the success of the rheostat depends on this contact device, it must be carefully made and the lower spring piece divided on each side as at N, so there may be four contacts on the

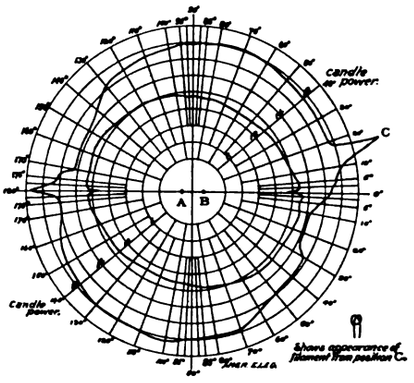



FIG. 8.—DIAGRAM OF HORIZONTAL CANDLE POWERS ON TWO LAMPS, ONE WITH COILED, THE OTHER WITH PLAIN HORSESHOE FILAMENT.

rheostat wires. With this rheostat the volts on a 16-c.p. 110-volt lamp can be controlled over a range of ten volts by almost imperceptible steps and one amp. can be put through it continuously without dangerous heating. The whole thing is held together by wood screws from the ends, O, into the rod J, and then screwed in place at the side of the frame.

After the photometer is all put together and mounted on a side wall, the whole thing must be given a couple of coats of a dead-black paint, and the wall immediately behind the instrument painted the same way. A dark room need not be provided. All very bright lights, however, must be absent from the vicinity of the instrument or turned out when it is in use.

### HOW TO USE THE PHOTOMETER.

Two needs must be supplied before any work can be done with the finished instrument. There must be standard incandescent lamps and a thoroughly reliable voltmeter. The incandescent lamps may be purchased from any of the larger lamp companies, marked with the voltage at which they give 16-c.p. and from what direction they must be viewed to give this c.p. Sixteen-c.p. standards must be used. By a thoroughly reliable voltmeter is meant one which has 110 volts at its terminals when the needle points to this, that always comes to a 110-volt reading when 110 volts is applied, and which can be read to one-fifth of a volt. Unless such a voltmeter is used, only very rough c.p. measurements can be made. Errors as much as ½-c.p. to 1-c.p. in 16 will come in, due to this cause alone, with a voltmeter in use whose readings are slightly in doubt. The circuit used must be one on which the e.m.f. at the lamp can be held steady for a similar reason. An ordinary 16-c.p. lamp changes c.p. about one unit per volt change in applied e.m.f. at the normal or rated e.m.f.

Having the standards and the voltmeter for the work, proceed to measurements this way. Two men are required; one to watch the voltmeter and change lamps, the other to work the car. Connect the circuit, put one of the standards in the socket, set it at its marked voltage and turned so one views it from the photometer car in a direction which makes its c.p. sixteen, light the argand burner, put the car so its index is at mark 16, and adjust the slot at the argand until the grease spot disappears. The argand lamp has now become the standard and is assumed to stay at fixed c.p. for further work. Next remove the standard lamp, put in one whose c.p. is to be determined, bring it to a proper applied e.m.f., and while one man reads the voltmeter and keeps the lamp at a constant terminal potential difference, the other one moves the car backward and forward, seeking a place where the grease spot cannot be distinguished from the surrounding paper, and when the place is found he reads the c.p. of the lamp now in the socket. So work is proceeded with, a return being made periodically to the standard to check the argand burner, which is the working standard, and perhaps also to other lamps as well to procure check readings of their c.p. A check on the argand by the incandescent lamp standard is of course made by putting the car at 16-c.p., adjusting the in-



FIG. 9.—A VIEW OF A ROTATING SOCKET.

candescent lamp in position and applied e.m.f. and observing whether the grease spot is still invisible. The one handling the car must keep his eye solely for observations of the grease spot and will not be able to do good work until he has gotten accustomed to it by ten minutes preliminary work. Also a person without experience in photometric measurements will not be able to get good, that is, concordant and correct results. A practiced observer will have results agree with this photometer so that individual observations never differ by more than a half c.p. in sixteen.

It will be very unusual for the grease spot to simultaneously disappear from both of the images in the mirrors for any one position of the car. This is mainly due to difference in the color of the lights used. Old incandescent lamps are less troublesome than new ones in this respect. In making a reading one should set the car to a position where the difference in tint of spot and field is the same, whichever mirror he views.

It must be observed that when making measurements no reversing of car is to be done, nor is there necessarily a dark room. Simply avoid lights or white surfaces before the eyes of the observer and have the lights in the vicinity of the instrument as few as possible, of as small c.p. as possible, and constant in position and c.p. If one can just manage to read newspaper print from the surrounding lights it will be dark enough. Avoid light most carefully at the incandescent lamp end.

If 110-volt lamps are to have their c.p. determined it commonly happens that the dynamos run at 110 volts. Hence it is well nigh impossible to get 110 volts at the photometer and in any event the rheostat would be useless. One should have a few small storage cells to put in series in the circuit on this account, to raise the e.m.f. to about 120, and then there is abundant opportunity to procure the 110 volts steadily, even under considerable fluctuations in the e.m.f. on the circuit.

A 16-c.p. lamp does not measure 16-c.p. when viewed from any direction. There is a good deal of variation in c.p. according to the direction from which one views the lamp, and especially is this true for coiled or looped filaments. Even the c.p. in a plane at right angles to the lamp axis, the horizontal c.p. is irregular. One can readily see this for himself by holding a piece of white paper near a lighted lamp and observing the bright streaks of light in certain directions. The kind of variation which exists is shown by two curves of horizontal c.p. plotted together in Fig. 8. These were taken from two lamps, one of which had a coiled filament and the other a plain U-form filament.

Most lamp manufacturers are now rating their product by the c.p. measured when the lamps are rotating on a vertical axis at 180 r.p.m.—a value decided on at the National Electric Light Convention a year or two since. A rotating socket is not included in the photometer design here given. There is, however, a cut of a rotating socket recently built for use in the Electrical Laboratory at Drexel Institute here shown, which might replace the incandescent lamp stand in the design given in this article. The one shown in the cut has embodied in it certain features worth noting. There are four brushes rubbing on four contact rings. Two carry current into and out of the lamp through a socket so arranged that the voltmeter connected through the two other brushes is actually connected to the lamp terminals, and so the true e.m.f. on the lamps is known. To maintain a steady rate of rotation the little motor shown is run by two storage cells given up to this duty alone. The speed of the rotating socket is also under control and can be varied through all necessary

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limits by shifting the little rubber-covered pulley to different radii under the large rotating disc, which is mounted on the stem of the lamp whose c.p. (that is, mean horizontal c.p.) is to be determined. With proper tools and facilities such a rotating device, or one equivalent, can be put on the photometer here described and so a very complete instrument be had.

The standard lamp is better if not rotated. Care must be taken that the standard is not viewed from a position near to one like C, in the figure of horizontal distribution, however, where the turning of the lamp through only five degrees varied the c.p. by more than five units. A plain U-shaped

TABLE FOR CONSTRUCTION OF CANDLE-POWER SCALE.

| Distance from Slot Board in Inches. | | Candle-power to be Marked on Scale. |
|---|---|---|
| Exact Value. | Nearest 64th. | |
| 21.961 | 21 63/64 | 30 |
| 22.198 | 22 13/64 | 29 |
| 22.444 | 22 29/64 | 28 |
| 22.7 | 22 45/64 | 27 |
| 22.967 | 22 61/64 | 26 |
| 23.246 | 23 15/64 | 25 |
| 23.537 | 23 35/64 | 24 |
| 23.842 | 23 55/64 | 23 |
| 24.162 | 24 11/64 | 22 |
| 24.498 | 24 31/64 | 21 |
| 24.8525 | 24 57/64 | 20 |
| 25.227 | 25 15/64 | 19 |
| 25.623 | 25 39/64 | 18 |
| 26.0435 | 26 3/64 | 17 |
| 26 491 | 26 31/64 | 16 |
| 26.97 | 26 61/64 | 15 |
| 27.4825 | 27 33/64 | 14 |
| 28.035 | 28 9/64 | 13 |
| 28 634 | 28 41/64 | 12 |
| 29.285 | 29 19/64 | 11 |
| 29 634 | 29 43/64 | 10.5 |
| 30.000 | 30 | 10 |
| 30.384 | 30 25/64 | 9.5 |
| 30.790 | 30 51/64 | 9 |
| 31.219 | 31 15/64 | 8.5 |
| 31.672 | 31 43/64 | 8 |

TABLE FOR CONSTRUCTION OF NO. 2 CANDLE-POWER SCALE.

| Distance from Slot Board in Inches. | | Candle-power to be Marked on Scale. |
|---|---|---|
| Exact Value. | Nearest 64th. | |
| 24.027 | 24 1/64 | 45 |
| 24.212 | 24 13/64 | 44 |
| 24.400 | 24 25/64 | 43 |
| 24.593 | 24 39/64 | 42 |
| 24.794 | 24 51/64 | 41 |
| 24.997 | 25 | 40 |
| 25.210 | 25 13/64 | 39 |
| 25.429 | 25 29/64 | 38 |
| 25.651 | 25 41/64 | 37 |
| 25.884 | 25 57/64 | 36 |
| 26.124 | 26 1/64 | 35 |
| 26.370 | 26 23/64 | 34 |
| 26.625 | 26 41/64 | 33 |
| 26.890 | 26 57/64 | 32 |
| 27.163 | 27 11/64 | 31 |
| 27.451 | 27 29/64 | 30 |
| 27.746 | 27 47/64 | 29 |
| 28.052 | 28 3/64 | 28 |
| 28.374 | 28 23/64 | 27 |
| 28.707 | 28 45/64 | 26 |
| 29.055 | 29 3/64 | 25 |

filament is much the best for a standard lamp.

The candle power of 8-c.p. lamps can readily be obtained with this photometer also. Put a standard 8-c.p. lamp, at some marked voltage, in the lamp socket; put the car at 16-c.p. and adjust the slot at the argand burner until the spot disappears. Then proceed to measure 8-c.p. lamps as though they were 16's, halving the value of c.p. read on the scale in each case for their real candle power. A similar method may be used also in determining the value of the candle power procured from 32-c.p. lamps. Use a standard 32-c.p. lamp as in case of the standard 8-c.p. above, and when readings are made on the candle power scale double the value obtained in each case. Unless the gas used is intrinsically of very good candle power and the argand burner is put very close to the slot board, this last cannot be done since the gas burner will not give enough light. If it is a possible plan carefully avoid any flickering edges of flame showing through the slot when it is viewed from the car position. The following alternative method of measuring 32-c.p. lamps will always be satisfactory.

Set up a second lamp socket (number 2) fifteen (15) inches to the right of the one already provided in the regular construction, or seventy-five (75) inches from the slot. Construct a second scale (number 2) under the one already made (number 1), to be used only when the lamp under test is in the more distant socket.

This scale will be constructed by measurements given in the table below, all measurements being from the slot before the argand lamp.

Use 16-c.p. standard in socket number 1, put the car at 16 candle power on scale number 1, and set the argand lamp by it so the spot disappears. Then put the 32-c.p. lamp, whose candle power is desired in number 2 socket, and measure its candle power in the usual way, but reading its candle power on number 2 scale. If the two sockets are connected in parallel they will be ready for operation alternately at any time, the same instruments and rheostat being used without any change in connections.

## AMERICAN TELEPHONE PRACTICE.

### SELF-INDUCTION AND CAPACITY.

BY KEMPSTER B. MILLER.

Self-induction and capacity play such important parts in the question of long-distance telephone transmission, and seem so little understood among the rank and file of telephone workers and users that this chapter will be devoted to an elementary and non-mathematical discussion of these two phenomena with a view to explaining their existence and effect in a simple manner, rather than to throw any new light upon the subject.

Ohm's law states that for a steady flow of electricity in a given circuit the amount of current in amperes is equal to the electromotive force expressed in volts, divided by the resistance of the circuit expressed in ohms. In algebraic form this becomes the well-known equation:

$$C = E/R$$

Where C represents the current in amperes, E the electromotive force in volts, and R the resistance of the circuit in ohms. Knowing any two of the above quantities, the third may be determined from the equation already given, or from the following, which are derived from it:

$$E = CR$$

and $$R = E/C$$

These three equations, which are merely different ways of expressing Ohm's law, are the most useful in the entire science of electricity. It is unfortunate for an easy understanding of telephony that these equations in their simple forms hold true for a steady flow only, and that when currents which are rapidly changing in value or in direction are considered, we must face a more complex set of conditions.

An electric current flowing through a conductor sets up a field of force about the conductor throughout its entire length. This field of force consists of magnetic lines extending in closed curves about the conductor, and is often termed a magnetic whirl. A freely suspended magnetic needle placed within this field of force will tend to assume a direction corresponding to the direction of the lines of force, and therefore at right angles to the conductor.

If the current flowing in the conductor is maintained at a constant value and in the same direction, the field of force about the conductor will not change. On the other hand, if the current strength fluctuates, the field of force will become more intense and will expand while the current strength is increasing, and will become less intense and will therefore contract while the current strength is decreasing. If the current changes its direction, the field of force existing is entirely destroyed, and is built up in an opposite direction at every such change.

Whenever there is such a relative movement between a conductor and the lines of force of a magnetic field as to cause the conductor to cut the lines, or the lines to cut the conductor, an electromotive force is set up in the conductor which tends to cause a current to flow. The direction of the electromotive force will depend on the direction of the lines and on the movement of the conductor, and its value will depend on the rate of cutting. The field of force may be set up either by a magnet or by a conductor carrying a current, and in either case the phenomenon just described is called electromagnetic induction.

If two wires are formed into parallel coils, each having a large number of turns, then the lines of the field of force set up by the coil carrying the current will cut many of the turns of the other wire, thus inducing an electromotive force in each turn; the result being that the sum of all the electromotive so induced forces will be added, thus producing a much greater effect than if each wire consisted of but a single turn. Furthermore, if the two coils are wrapped about an iron core, the field of force due to the coil carrying the current will be greatly strengthened, and therefore the electromotive force induced in the second coil will be greatly increased, owing to the greater rate of cutting of lines caused by the changes in the strength of the current. This is due to the fact that a given magnetizing force,

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or force which tends to set up a field of force, will produce a greater number of lines in iron than in air.

It is evident that in a coil of wire carrying a current each turn of the coil is surrounded by a field of force, and that each turn must therefore lie more or less within the fields of force of all the other turns. Each turn will therefore have an inductive action upon all the other turns when the current through the coil is varying. Whenever a diminution of the current occurs the decreasing number of lines of force set up by any one turn will act on each of the other turns to induce an electromotive force tending to cause a current to flow in the same direction. The decreasing field of force around each one of the turns will act in a like manner on all of the other turns, and as all of the electromotive forces in all of the turns will be in the same direction as the current, which is already flowing in the coil their effects will be added and will tend to prolong the flow of current. On the other hand an increase in the current will cause an increasing number of lines to suround each turn, and this increase around any one turn will induce electromotive forces in each of the other turns in the opposite direction to that producing the current already flowing. This phenomenon of induction between the various parts of a single coil of wire each on the other is termed self-induction.

In view of the fact that a decreasing current induces an electromotive force tending to produce a current in the same direction as that already flowing, while an increasing current induces an electromotive force tending to produce current in the opposite direction, it follows that the general effect of self-induction in a circuit is to tend to prevent any changes in current from taking place in that circuit. This accounts for the fact that coils of wire, such as those forming electromagnets, tend to so greatly reduce the flow of voice currents through them; one of the best illustrations being that used in the bridging bell system of party lines, where the ringer magnets are purposely wound with a great number of turns and provided with long, heavy iron cores for the purpose of increasing the self-induction.

It is quite evident that in circuits containing self-induction and subject to rapidly fluctuating electromotive forces, the tendency of self-induction to prevent changes in the current will always cause any change in current to lag slightly behind the electromotive force which produces it. Where the electromotive force impressed upon a circuit varies according to the law of sines, the electromotive force produced by self-induction lags a quarter of a phase or 90° behind the current flowing in the circuit. That this is so may be seen from the fact that the electromotive force of self-induction is a maximum when the current producing it is changing most rapidly, and is zero when the current producing it is not changing at all. The maximum rate of change of the current flowing in a circuit occurs when the current is passing through zero, and its minimum rate of change occurs at the crests of the wave, that is, at its maximum points. It therefore follows that the electromotive force of self-induction is a maximum when the current in the circuit is zero, and is zero when the current is a maximum. This evidently indicates a phase difference of 90°, and we have already seen that this phase difference is a lagging rather than a leading one.

In circuits containing only non-inductive resistance the electromotive force impressed upon the circuit has only to overcome the ohmic resistance, and the value of the current may be obtained at any time by a direct application of Ohm's law. Where self-induction, however, is added the impressed electromotive force, if it be a varying one, must overcome not only ohmic resistance, but the electromotive force of self-induction; and then the current equation becomes

$$\text{Current} = \frac{\text{Electromotive Force}}{\text{Impedance}}$$

The word impedance in this equation may be termed the apparent resistance, and the apparent resistance in circuits having self-induction is always greater than the ohmic resistance. In fact, I, the impedance, is equal to

$$\sqrt{R^2+4\pi^2f^2L^2}.$$

Where f is the frequency of alternations and L is the coefficient of self-induction—a term denoting the total number of lines of force set up in a given coil when traversed by current of unit strength. The equation flow of current may then be written

$$C = \frac{E}{\sqrt{R^2+4\pi^2f^2L^2}}$$

Which is the equivalent of saying that the current flowing is equal to the electromotive force divided by the aparent resistance.

The current flowing in a circuit in which self-induction and resistance are present is the resultant of that produced by the impressed electromotive force and the electromotive force of self-induction. The greater the electromotive force of self-induction the greater will be the lag of the current behind the impressed electromotive force. Furthermore the greater the self-induction the greater will be the apparent resistance or impedance, and consequently the smaller will be the current flowing. The above formula applies only to currents varying according to the sine law, but telephone currents do not vary according to this law, or according to any other definite law, so far as we have been able to determine. This does not, however, destroy the significance of the formula as applied to telephony. Fourier's theorem states that any complex periodic wave motion may be considered as being made up of a number of simple wave motions having 1, 2, 3, 4, etc., times the rate of vibration of the complex wave motion. Telephone currents are very complex and are composed not only of a fundamental tone, but of many overtones; it is by the various blending of these overtones with regard to their relative loudness and their relative positions in phase with respect to each other, that articulate speech is produced. A consideration of the formula for the flow of current, just given, shows that the effect of self-induction is greater upon currents of high frequency than upon those of low frequency, for as f, the frequency, increases, the value of the impedance or the apparent resistance increases, and, therefore, the value of the current decreases. In other words, self-induction tends to weed out the higher overtones in preference to the lower ones and the fundamental tone, thus rendering speech indistinct, as well as reducing its volume.

## INTERIOR WIRING.

BY CHARLES E. KNOX.

### FEEDERS AND MAINS.

In this number the method of installing feeders and mains, known as exposed work, will be considered.

For the purpose of discussion this portion of the subject may be divided into four parts, namely:

1st.—The wire or conductor.

2d.—The insulator.

3d.—The rack, hanger, clamp or other device for holding the insulator.

4th.—The method of supporting the insulator rack or hanger.

1st.—The Wire or Conductor.—It is obvious that a different kind of insulation or protective covering may be used in this class of work from that which is desirable or necessary in concealed work. In the latter case the insulating covering of the wire must be depended upon entirely for the insulation of the feeder system; for even if there be an insulating lining or coat (as there should be) in the conduit used, this should not be relied on to any great extent and should be considered chiefly as an additional protection. In the case of exposed work, on the other hand, we may, if we desire, depend entirely on the insulator for the insulation of the system. For this purpose then it is only necessary to have such a covering on the wire as will prevent trouble from actual short circuits, grounds or such accidental contacts as might be caused by placing a metal bar, monkey wrench, etc., across the conductors or from other similar causes. The liability of this occurring may be greatly reduced by covering the conductors as a whole with wire lathing, galvanized sheet iron or similar covering.

There are many kinds of insulating coverings which will accomplish this purpose other than rubber. Among these are the coverings used on the so-called weatherproof wire, and on the historic underwriters' wire. Even two or three wrappings of tape around the copper wire might suffice, although this would not be as durable and would probably cost just as much as either of the others. The weatherproof wire is best adapted for outdoor work, as it stands up well under changes of weather, moisture, etc. Its disadvantage is that it is not fireproof. Underwriters' wire on

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the other hand, is fireproof, but is not as good for the purposes to which the weatherproof wire is best adapted. Where the feeders pass outdoors from one building to another, weatherproof wire would be better than either rubber-covered or underwriters' wire.

Of course there are many cases (perhaps the majority) where it would be unwise to use any insulation other than rubber for this class of work. The selection of one or the other depends on many conditions, and each case would have to be considered separately and a decision made according to the conditions. With voltages of 200 or over the tendency to use rubber covered conductors should increase. The point is, however, that in exposed work it is possible in some instances to substitute other insulating coverings for rubber and thereby make a considerable saving in the cost of the feeder system.

2d.—The Insulator.—In this connection this term designates the rest or clamp for insulating the conductor from the supporting hanger, rack, beam, etc. It is very rare that any material is used at the present time for insulators for interior wiring other than porcelain. Glass might be used, but it has many, if not all, of the disadvantages of porcelain for this purpose, and more beside, while its only important advantage is its lower cost. Porcelain for insulators has many advantages. It has high insulating qualities, it is not (when glazed) hygroscopic to any

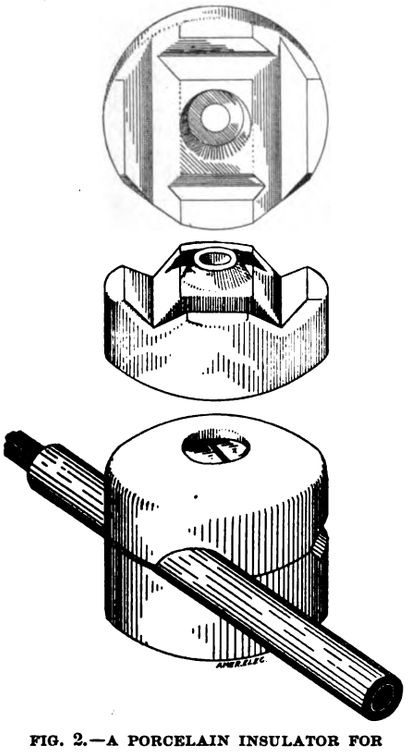


FIG. 2.—A PORCELAIN INSULATOR FOR SMALLER WIRES.

extent, it can be molded in a great variety of shapes and is cheap. Its great disadvantage is its fragility. Therefore in adopting or designing a porcelain insulator for this class of work it is important to select such shapes and forms as will mitigate or avoid this weakness.

Briefly expressed, the insulator should be "chunky." In fact, this word best expresses the idea of the requirement to which all designs of insulators made of porcelain should conform in order to avoid breakage. Any form of insulator having thin projecting edges or lips, or which have been weakened by screw holes or grooves, should be discarded and stouter and more compact designs adopted. If this point be not strictly observed, there is bound to be trouble. I have known cases where a poor design of insulator has been used, and the breakage has been as high as 20 per cent.

Fig. 1 shows a good stout form of insulator for large wires. As will be seen from the drawing, this insulator is split so that while the wire passes through the center of the insulator, the insulator may be taken out at any time in case of breakage and be replaced by another. Fig. 2 shows a fairly good form of insulator for smaller wires. This insulator has the questionable advantage of being to a certain extent universal, having several sizes of grooves in the two parts of the insulator, so that by placing the two parts in varying positions, different sizes of wire may be accommodated.

3d.—The Insulator Rack, Clamp or Holding Device.—For fairly small conduc-

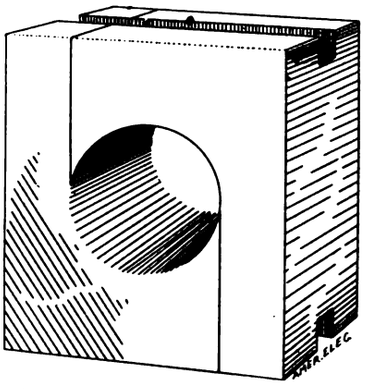


FIG. 1.—A HEAVY PORCELAIN INSULATOR.

tors for which insulators of the type shown in Fig. 2 are used, each insulator may be secured separately by means of a screw, passing through the hole in the insulator, to the beam, wall or ceiling, as the case may be. Where there are a number of these in a row, however, it is a better plan to secure the insulators side by side to a channel iron, which is fastened in turn to the beam or wall.

For insulators of the type shown in Fig. 1, a frame or rack similar to the design shown in Fig. 3, is most suitable. As shown in the drawing, this consists of angle or T iron, to which are secured straps or bars of iron projecting outwardly, into which the slot in the insulator fits. On the outer side of the rack, each insulator is secured in place by separate straps, which at the same time serve to stiffen the rack. By removing any strap the corresponding insulator (and consequently the conductor) may be removed without disturbing the remainder. Where such strength and rigidity is not necessary, the horizontal straps on which the insulators rest may be replaced by ⅜-in. or ½-in. bolts of proper length for the size of the insulator. Of course there is no end to the variety of hangers or racks that might be designed for this purpose.

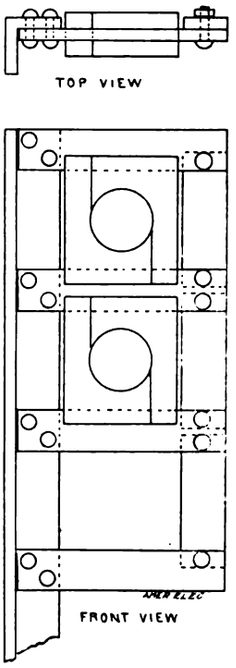



FIG. 3.—A RACK FOR PORCELAIN INSULATORS.

In some instances many different shapes and sizes of racks are necessary for the same run of conductors in order to overcome peculiar conditions encountered in the course of the feeders. Each rack must of course be fitted and adapted for its particular location and requirement.

4th.—Method of Supporting Rack or Hanger.—Where there are beams, girders, etc., to which the rack supporting the insulator may be fastened, it is easy to get a firm support for the racks. Beam clamps to which the racks are secured may be used, or else the beams may be drilled and tapped and the racks fastened in place by stout machine screws. This makes a much more secure support than if the racks were screwed to wood, and also has the advantage of greater security in case of fire, a point which in many instances should be borne in mind.

When the insulating rack must be secured to a brick wall or ceiling, care should be taken to obtain a secure fastening. For this purpose expansion bolts, toggles or some similar device should be used. Never depend on a wooden plug for a means of getting a fastening for a screw; sooner or later (generally sooner) these plugs are bound to get loose and pull out, even if the wood be seasoned. They are a "delusion and a snare," and are the more deceiving, because they seem fairly firm when first put in the brick.

It is frequently necessary to stiffen or guy the racks where they are subject to any great strain owing to the pull or weight of the wires. This is especially true when the feeders change their course

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(as in turning a corner). For this purpose iron straps or stout steel wires may be fastened to the ceiling or wall at one end, and to the rack at the other end.

As far as possible a direct course or run should be selected for the feeders, for it is probably even harder to make bends or turns in exposed work than it is when the feeders are run concealed. Avoid crossing any pipes, ducts, etc., whenever possible. Steam pipes particularly should be avoided, as both weatherproof and rubber insulation are affected by high temperatures. The conductors should not be allowed to rest or touch anything but porcelain (if they have weatherproof or fire underwriters' insulation) through out the entire course.

When the route has been selected, the start should be made at the switchboard for there is the greatest congestion and

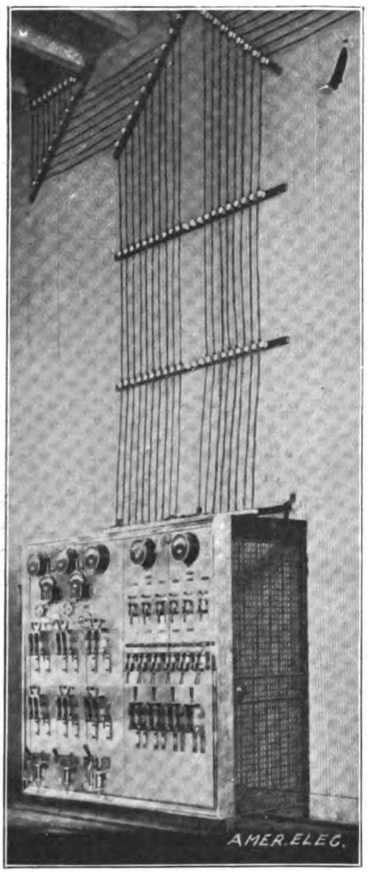



FIG. 4.—FEEDERS RISING FROM SWITCHBOARD.

there the greatest ingenuity must be exercised in order to obtain satisfactory results. In most cases the switch with which a given feeder must connect is prescribed and this makes it all the more essential to start at the board in order to avoid crossing to make the proper connections.

In all cases where the feeders are large or numerous it is well to make a small working model of the feeder system, using small wire or cord for wires and pasteboard for racks. It is much easier handling No. 18 wire than 1,500,000 c. m. and cardboard than iron. Then when the course has been properly mapped out the racks should be set in place throughout the entire course. When the insulator used is of the type shown in Fig 1, one-half of each insulator for each feeder should be set in place in the rack, the conductor then being laid on this half and then the remaining half of the insu-

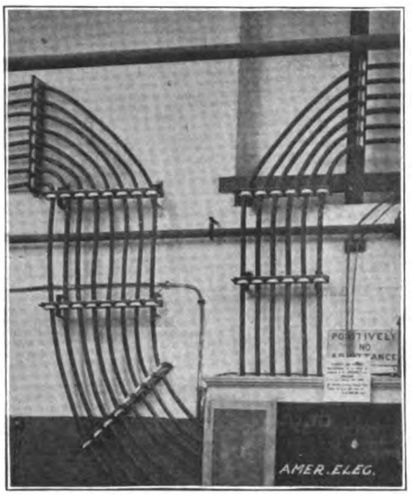



FIG. 5.—A RUN OF HEAVY FEEDERS.

lator put in place and then the straps should be fastened in position. This is a much quicker method than pulling the wires through the insulator and also avoids abrasion. Where it is necessary to pass through walls, partitions, etc., the wires should be protected (unless covered with rubber) by porcelain sleeves or tubes (preferably split in two parts), which are properly protected from breakage. If the conductors be insulated with rubber, sections of lined conduit may be used.

Fig. 4 shows an example of medium-sized feeders rising from a switchboard to the ceiling. In this case the voltage of the installation was 240 volts and rubber covered wire was used. The insulators were the ordinary porcelain "knobs," fastened by machine screws to channel iron, which in turn was fastened to the

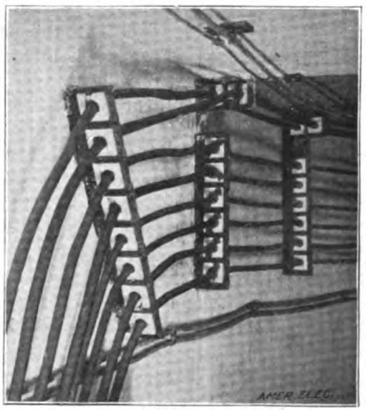



FIG. 6.—A DETAIL VIEW OF FEEDERS SHOWN IN FIG. 5.

iron frame of the partition. The wires were "tied" in the regular manner to the outside of the insulator.

Fig. 5 shows a view of very heavy feeder conductors. In this case the insulator used is of the form shown in Fig. 1, rack being of the design shown in Fig. 3. The wire is triple-braided weatherproof. Fig. 6 shows another view of the same installation.

## STEAM AND WATER STOP VALVES.

### THROTTLE, BLOW-OFF AND SPECIAL VALVES.

Among the improved stop valves to be found in use, and on the market, are many forms of special design which were made to overcome some difficulty. Trouble used to be the constant companion of the old-fashioned valve user, and the manipulator of plug valves used to look for

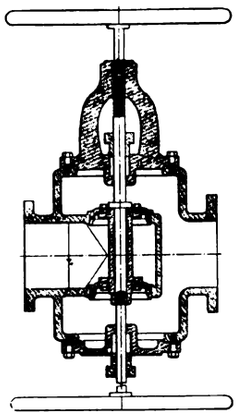


FIG. 1.—DOUBLE-BEAT THROTTLE VALVE.

trouble when he hunted up his valve wrench. But time and engineering have changed all that, until almost every difficulty has been overcome by the use of a specially designed or constructed valve, fitted for the particular case in hand.

The improvement in throttle valves has been most marked. Imagine the circumstances attending an attempt to open a plug valve in a 10-in. steam main against 125 lbs. gauge boiler pressure! It would require a small army of laborers to manipulate such a valve—and plenty of time, also. But with the improved

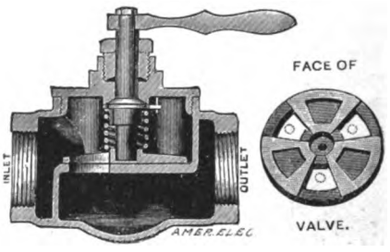



FIG. 2.—GOLDSMITH THROTTLE VALVE.

throttle valves now in use the engineer can control the largest engine with a touch of the fingers.

The throttle valve illustrated by Fig. 1 is a representative of what has been done to advance "throttle valve engineering." This valve was designed by Charles H. Manning, Superintendent of the Amoskeag Company, and was made for the Jefferson mill. This valve is of the "double-beat" variety, and gives the full opening of a 9-in. pipe in two and one-half turns of the hand wheel. As shown by the en-

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graving, the valve is nearly perfectly balanced and the stem is well supported as it passes through both sides of the valve and carries two stuffing boxes and bearings, besides a third support in the yoke which forms the nut. Being thus supported in three places, there is little danger of spring in the valve stem, or of clattering discs when the valve is being closed. For this illustration and description, also for several others in this article, we are indebted to "Power." Credit is also due to the "American Machinist" and the "Paper Trade Journal" for other illustrations used herewith.

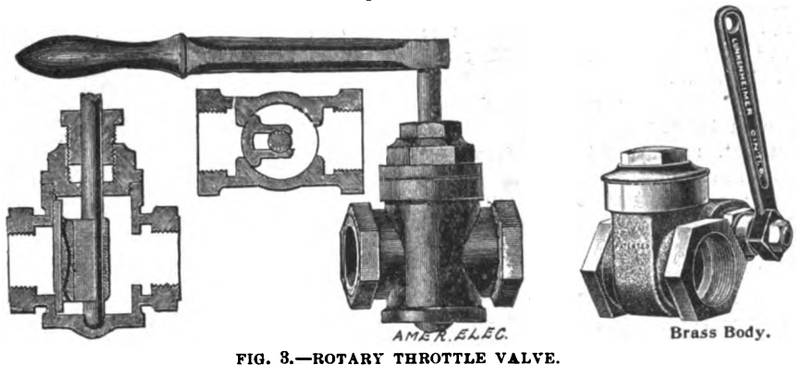



FIG. 3.—ROTARY THROTTLE VALVE.

Fig. 2 illustrates a form of valve made by the Roe Stephens Manufacturing Company, and known as the "Goldsmith Throttle Valve." It is also used for main stop valves, but is especially adapted to large stationary and marine engines, and to large steam pumps working automatically. The design is for the purpose of preventing uneven seat wear and the keeping of scale or sediment from the seats. The discs never leave the seats, and they follow and take up their own wear. The action is positive, and easy and quick under heavy pressures.

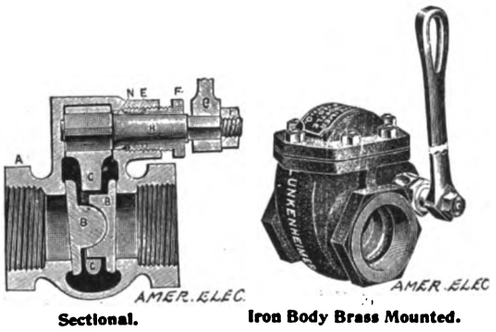



FIG. 4.—LEVER THROTTLE VALVE.

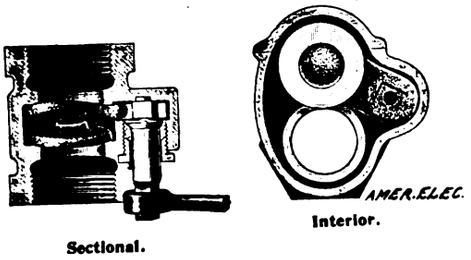



FIG 5.—HANDY GATE VALVE.

A valve of the rotary type, made by the Haydensville Manufacturing Company, is shown by Fig. 3. This is a very quick acting form of valve and compensation for wear is provided for. Only about one-fourth of a turn is required between "full open" and closed, and the valve, having but one stuffing box, and no endwise motion to the stem, leakage is reduced to a very small quantity. The method of attaching valve to spindle is shown in the sectional details of the drawing, and the valve may be removed bodily, at any time, by simply removing the bonnet.

Quite a number of "Swing Lever Gate Valves" are used for throttling purposes. Fig. 4 shows one type and its details as made by the Lunkenheimer Company. This can be operated by a lever on a cord attached thereto, or by a rod attachment. The discs are loose and provided with ball and socket bearings, as shown. They are claimed to wear evenly and make a tight joint. The principle of this valve is to wedge the discs by means of the ball and socket joint, with a full bearing, between the tapering seats. The engraving shows both the iron and brass forms, the former being brass mounted.

A "Handy Gate Valve," made by the same company, is shown by Fig. 5, and this valve must not be confounded with the throttle in the preceding illustration. This valve also has the loose discs and ball joint, but it is not intended for throttling purposes. The stem carries a rotating flange upon which bears a non-rotating friction washer, whereby the necessary friction can be brought to bear on the flanged stem to make it work as easy or as hard as desired. This valve disc is attached directly to the stem by means of an arm, while the throttle valve (Fig. 4.) has a yoke which slips over both discs.

Another form of "lever gate" throttle valve is made by the Wm. Powell Company and illustrated by Fig. 6. This valve is known as the "Star lever throttle," and has double discs which are centered on studs travelling within a slotted carrier, and being confined between the vertical guides of the shell, are constantly rotated at each throw of the lever, causing a continual change of position and assuring a uniform wear of both disc and seat.

This valve carries a wedge block which is loosely confined within the slot of the carrier, between the central studs of the discs, so that at the closing throw of the lever the discs slide up over the wedge and are gradually and firmly forced to their seats. A reverse motion withdraws the wedge and releases the discs. Should the wedge or disc studs wear after a time, from constant use, all that is required to restore the valve equal to new is to put in a slightly thicker wedge, or add a thin sheet of metal thereto. One point is that the construction of these valves admits of their being set at any desired opening.

A unique form of throttle valve, shown by Fig. 7, was designed by Fred W. Salmon, with the intention to combine all the conveniences of the ordinary valve in stopping and starting, from the working side of the engine, also for making it possible to quickly stop the engine in case of necessity, from the other side thereof, should the governor break or unusually high speed from some other cause make a quick stop necessary. The construction of this valve shows a lever upon the side opposite the usual hand wheel, and the nut in which the threaded spindle works is attached to the lever by properly arranged connecting links. A clamp screw locks the lever in any position, and in case of necessity a pull upon the lever closes the valve instantly by bringing down the nut, screw-stem, disc and hand wheel, without the engineer having to get into line with any of the moving parts of the engine, or having to give a hand wheel several turns.

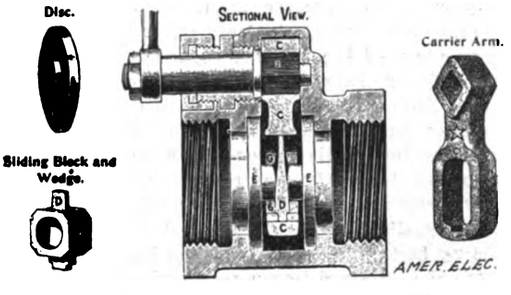



FIG. 6.—STAR LEVER THROTTLE VALVE.

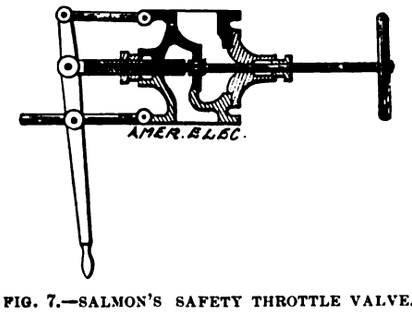



FIG. 7.—SALMON'S SAFETY THROTTLE VALVE.

A good throttle valve is to be desired with every steam engine, but it does not begin to compare with the importance of

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a reliable blow-off valve on each steam boiler. The importance of this fitting is so great that many inventions have been introduced to steam users. The old plug valve, or stop cock, used to be the reliable standby for this purpose, and it is still used to a considerable extent where the march of progress has not driven it out

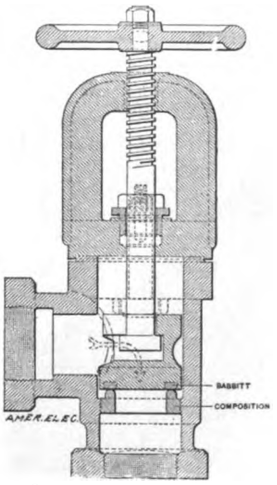



FIG. 8.—IRON BLOW-OFF VALVE.

in favor of a better valve. The form shown by Fig. 8 was designed by an engineer and it is made by the Kelly & Jones Company. This valve is particularly fitted for high steam pressures and muddy or dirty feed water like that from the Ohio or the Mississippi rivers. The side opening of the valve is connected to the boiler, and the construction is such that but little water can escape until the valve has raised far enough to give almost a full opening. This prevents the cutting caused by gritty water passing at high velocity against and under the disc, when only slightly raised. The valve is a sliding fit in the barrel, and has babbitt metal hammered into a recess where it comes in contact with the seat. This valve also possesses the desirable cer-

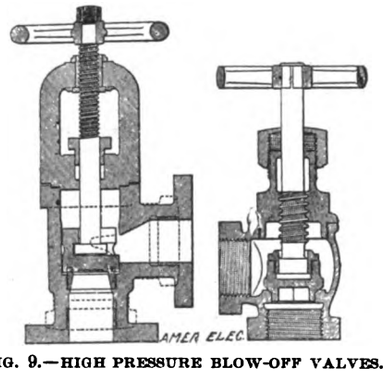



FIG. 9.—HIGH PRESSURE BLOW-OFF VALVES.

tainty, for a blow-off valve, that it can be closed after opening.

Another form of blow-off valve, suitable for very high pressures—up to 250 pounds—is shown by Fig. 9. These valves are made by the Crane Company and may be had in either iron or hard metal. Here, also, the disc is a pretty close fit in the body of the valve so that the disc or plug has to be raised a considerable distance above the seat before discharge takes place. The benefits therefrom are the same as with the preceding valve described.

Fig. 10 presents still another angle blow-off valve, with further peculiarities of construction. The reversible bearing faces in the iron disc are filled with babbitt metal. The disc is solid and fits the barrel closely, so that no scale or sediment can get on top so as to prevent the disc from being raised readily when necessary. The disc is reversible and can be changed at will, thereby increasing the life of the valve.

The seating faces are dovetailed slots filled with babbitt metal, which can be melted out, recast, and then faced off when necessary to renew the wearing surfaces of the valve. The entire trimming can be taken out of the valve by removing the bonnet, then, by unscrewing the small plug at the bottom of the disc and the disc lock-nut around the stem, the disc can be readily inserted.

Some engineers put on two plug or globe valves in order to make sure that the blow-off does not leak. This has proved to be a good thing, although some people claim that it is inefficient, for if one valve

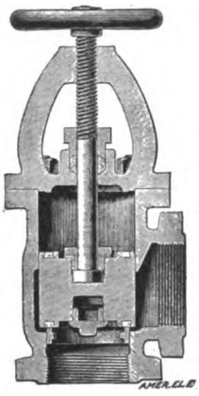



FIG. 10.—LUNKENHEIMER BLOW-OFF VALVE.

fails the other must take all the pressure, and may leak also. In practice this is not found to be the case. The pressure seems to be divided up between them, and each valve carries a share thereof—probably like two resistances in series.

Fig. 11 shows an adaptation of this idea as worked out by the Chapman Valve Manufacturing Company. Practically it is a pair of that firm's standard high pressure steam valves with removable bronze seats and flanged ends, the seats being interchangeable. The outside screw and yoke is to show beyond doubt, at all times, the position of the valves as to whether they are open or shut. In practice it is proper to close first the valve furthest from the boiler. This brings all the wear on the outermost valve, leaving the inner one to keep tight. This order is reversed when the valves are to be opened.

A form of blow-off valve which is coming into favor to a great extent is shown by Figs. 12, 13, 14 and 15. It is known as the "Y" valve, and possesses a good deal of merit, not only for blow-off purposes, but for other uses as well. Fig. 12 shows this form of valve as made by Jenkins Brothers. The construction is such that it has no pocket, or anything to obstruct the passage of steam or fluid. In closing, it shuts against the pressure. Its internal arrangement is similar to that of a regular Jenkins valve, and its giving a full opening and direct passage makes it especially desirable for the mud and dirt of a blow-off pipe discharge.

A somewhat similar form of Y valve is made by the Hydensville Manufacturing Company, and illustrated by Fig. 13. The

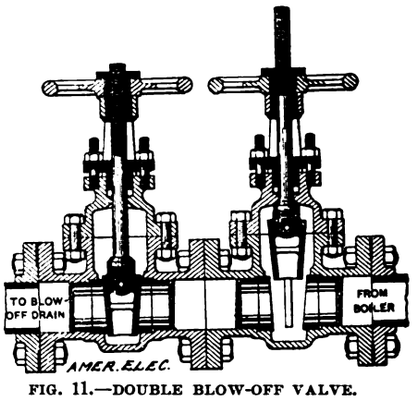



FIG. 11.—DOUBLE BLOW-OFF VALVE.

internal construction of this valve shows a flat seat with a disc fitting down upon it. There is considerable to admire in this arrangement, for there are no corners or crevices in the seat to catch or hold dirt or scale; therefore, when the fluid rushes under the nearly closed disc the flat seat is flushed or washed clean, allowing the disc to be seated without danger of being held up by scale or mud.

The Y valve shown by Fig. 14 is made by the Lunkenheim Company, and possesses several peculiarities. It is a brass to brass seat and disc, and is made regrinding in the manner described in a preceding paper on globe valves. It will be noted that the ends of the valve are male and female, and are always sent thus unless otherwise specified. All the benefits of solid seat valves are to be derived from this, as described for globe valves, and by

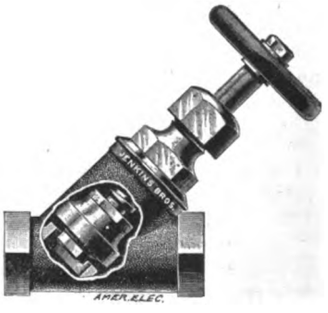



FIG. 12.—JENKINS Y VALVE.

occasional regrinding the blow-off may always be maintained tight and in good condition.

The elaborate form of Y blow-off valve shown by Fig. 15 is made by the Enyon-Evans Manufacturing Company, and the design of the body allows a clear passage when the disc is raised up, thus overcoming any tendency to clog. A hand-hole is provided with a quick acting lock and cover, which makes it easy to get into

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the valve in case of necessity. The valve seat is renewable and exchangeable and the disc is so made that the part thereof which comes in contact with the valve

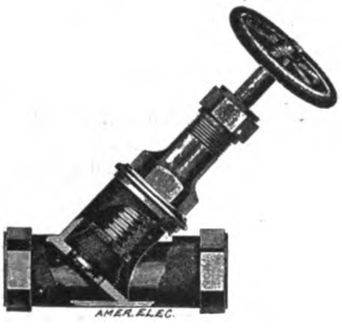



FIG. 13.—ADAMS Y VALVE.

seat can be renewed at will. It is claimed that the capacity of these valves is from 60 to 100 per cent. greater than other forms of Y valves of the same size.

A large number of special valves have been designed to meet peculiar conditions, and among such is the automatic stop

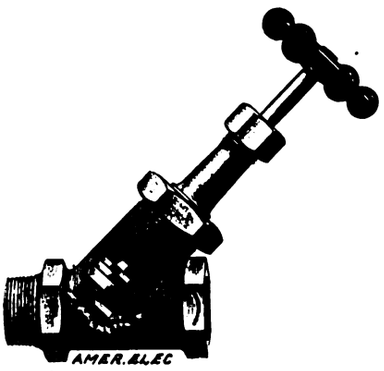



FIG. 14.—LUNKENHEIMER REGRINDING Y VALVE.

safety valve, shown by Fig. 16. This valve is made by the Riter-Barclay Manufacturing Company and is used for the purpose of stopping automatically the flow of steam from a broken main or pipe. A sudden increase in velocity of the steam carries the valve upward to its seat, where

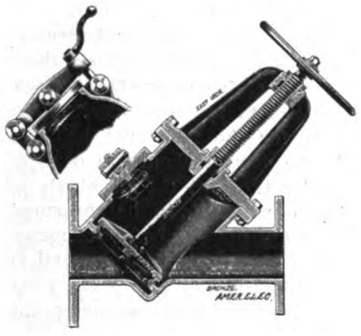


FIG. 15.—EYNON-EVANS Y VALVE.

it is retained by the pressure below it, thus preventing the further escape of steam. The degree of sensitiveness depends upon the weight of valve and size of flange. The threaded stem is to push the disc down from its seat when the valve is to be opened. By putting a disc upon this stem it can be made to serve as an ordinary stop valve, with the advantage that the stem cannot be left

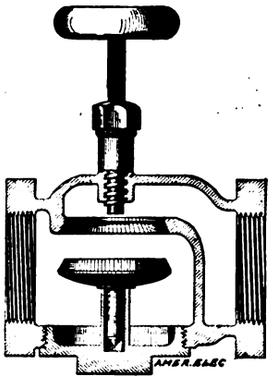



FIG. 16.—AUTOMATIC STOP SAFETY VALVE.

screwed down far enough to render the automatic valve inoperative without shutting off steam entirely.

## *Lessons in Practical Electricity*

### IDLE CURRENT AND POWER FACTOR.

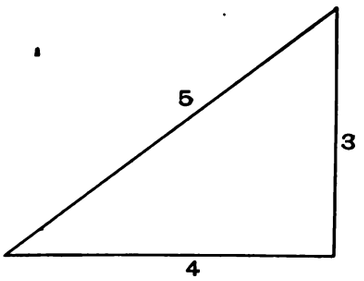
A somewhat unfortunate term which has been introduced into alternating-current nomenclature is "idle current." If the meaning of the phenomenon to which it applies is well understood, the term is a convenient one to use, but otherwise it is apt to lead to misapprehension. The term is actually a misnomer, for the apparent excessive current in an alternating current is not in all senses idle, the excess in fact being due to idle e. m. f.

To illustrate by an analogy, suppose that we have six storage batteries in a circuit, running a 12-volt motor, taking, under normal load, 10 amperes. Suppose now, that one of the cells is reversed, it would result in neutralizing a second cell, thus reducing the free e. m. f. to 8 volts. If now we substitute for the former 12-volt motor an 8-volt motor, the latter, if it does the same work as that in the first case equivalent to 120 watts, will require 15 amperes. Leaving aside the internal resistance and what actions may occur in the two neutralized cells, the battery will give forth the same energy in both cases and the motor will do the same amount of work. In the one case, however, 10 amperes will flow over the line, and in the other, owing to four volts being rendered idle, 15 amperes will flow. Therefore, the second arrangement will result in an additional line loss due to the larger current, though the work is the same in both instances.

Let us now take the cause of an alternating-current induction motor, which, if non-inductive, would use 10 amperes at 12 volts to perform its normal work. There is, of course, no induction motor that is non-inductive, but by placing in series or parallel with such a motor a condenser of proper capacity, the circuit as a whole will act as if non-inductive, for the reason that the capacity e. m. f. will neutralize the inductive e. m. f. Now suppose in such a circuit the condenser is withdrawn, and that the product of the volts and amperes becomes 180 instead of 120 when the motor is performing the same work as before.

We thus have a difference of 60 volt-amperes or apparent watts, as registered by instruments. Yet we know that, leaving aside any difference in motor losses, an equal amount of energy has been consumed in both cases. This discrepancy is due to the additional voltage required to overcome the inductive e. m. f. of the motor, which, in the first mentioned case, was neutralized by the capacity e. m. f.

Wherever current passes through a resistance, however, it will waste energy proportionate to the square of its strength, so that any increase of current in the second case is due to a decrease in the effect of the other factor of energy or




RELATIVE DIMENSIONS AND PHASE ANGLES OF IMPRESSED E.M.F. AND OHMIC AND INDUCTIVE DROPS.

e. m. f., which decrease is in turn due to the neutralizing effect of an inductive or back e. m. f.

In the two cases cited, the useful energy, as stated before, is 120 watts, while the volt-amperes, as recorded by the measuring instruments or apparent watts, are 180. The power factor is the ratio of these two, and in this case would therefore be 2/3 or 0.66.

Referring now to the accompanying cut, suppose that the impressed e. m. f. in an alternating-current circuit, as, for example, at the terminals of a choke coil, is 5 volts, and that the ohmic drop in the coil is 3 volts and the inductive drop 4 volts. The only e. m. f. usefully applied is that to overcome the ohmic drop, or 3 volts, the inductive drop acting as a counter e. m. f., and merely neutralizing a portion of the impressed e. m. f. The ratio, therefore, of the useful e. m. f. to the e. m. f. applied to the coil is as 3.5, and the power factor of the coil therefore is 3/5 or 0.6. That is to say, if 1 ampere is passed through the coil, though the product of the volts and amperes is 5 watts, but D 0.6x5 or 3 watts of energy will actually be used.

If we were to consider this case and use the idea of idle currents, the reasoning would be somewhat as follows: Since the e. m. f. measured is 5 volts, and the energy in the circuit but 3 watts, the energy current is 0.6 ampere and the idle current 0.4 ampere. By some, however,

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the idle current is assumed to be in phase with the inductive e. m. f., in which case its value would be to the entire current as the inductive e. m. f. is to the impressed e. m. f., or, in this case, 0.8 ampere.

In either case it will be seen that the idea of a portion of the current being idle is a false one. The true conception is that the greater the inductance in a translating device the more current is required to be delivered to it to do a given work, since part of the e. m. f. component of work is neutralized by the induction e. m. f. This additional current, while requiring no additional power at the machine, loads the line and increases both its drop and $C^2 R$ loss.

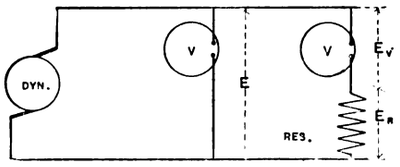
## Electrical Catechism

*293. What instruments are necessary for measuring resistance?*

High resistances may be measured by a voltmeter, by a bridge or by an ohmmeter. Low resistances may be measured by an ammeter and a voltmeter, or by a voltmeter and standard resistance. There are other methods suitable for laboratories with fine apparatus and skilled operators, but most measurements of resistance for practical purposes can be made with the apparatus mentioned.

*294. How can resistance be measured with a voltmeter?*

For this purpose a voltmeter of known resistance and a dynamo or battery giving constant voltage are necessary. First connect the voltmeter directly to the terminals of the dynamo, as suggested at A in the figure, or to some circuit connected with it, on which the current is




MEASUREMENT OF RESISTANCE WITH A VOLTMETER.

not changing. Carefully measure the voltage between the lines, and then connect in series with it the resistance which is to be measured, as shown at B in the figure, and again read carefully the voltage indicated on the voltmeter. This reading will be smaller than the first, because the resistance of the circuit is greater and less current goes through the voltmeter than before. Ohm's law, that current equals voltage divided by resistance, is equally true if turned around to read that resistance equals voltage divided by current. Now, when the same current flows through two resistances, the voltage or fall of potential through each is proportional to the number of ohms resistance in each. In the case above, the drop through the voltmeter is evidently the reading of the voltmeter, while the difference between that reading and the first one taken when the voltmeter was connected directly across the circuit, is the voltage drop through the resistance being measured. This may be expressed as follows: The resistance being measured equals the resistance of the voltmeter multiplied by the difference between the two readings and divided by the smaller reading.

*295. Give an example of measuring resistance by a voltmeter.*

Suppose we wish to measure the resistance of the field coil of a one-half kilowatt, 125-volt motor. The voltmeter has a resistance of 18,000 ohms. When connected directly to the circuit, it indicates 125 volts; when connected in series with the field coil of the motor, it reads 121 volts. (Of course in this measurement, it is necessary to place the voltmeter a sufficient distance from the motor so that its magnetic field will not influence the voltmeter.) The resistance of the motor field is then $18{,}000 \times (125 - 121) \div 121 = 595$ ohms.

*296. How can a voltmeter be used to measure insulation resistance?*

By connecting one side of the circuit with one side of the dynamo and connecting the other to it through the voltmeter. For example, suppose it is desired to test the insulation between the frame and the windings of the motor. Connect the frame of the motor to one side of the dynamo circuit; connect the other side of the dynamo circuit to one terminal of the voltmeter, and connect the other terminal of the voltmeter to the armature or field coil of the motor. Suppose, as before, that the voltage across the dynamo is 125 volts; when the voltmeter is connected to the motor as just described, it reads 2 volts. Then the resistance of the insulation is $18{,}000 \times (125 - 2) \div 2 = 18{,}000 \times 123 \div 2 = 1{,}107{,}000$ ohms.

*297. How can the resistance of the voltmeter be determined?*

The best instruments have the resistance marked on the case or on the box. If this is not found, it can be determined easily if one can get some high resistance of known value. As before, first measure the voltage across the line, and then connect the high resistance of known value in series with the voltmeter. The resistance of the voltmeter equals that of the other multiplied by the second reading and divided by the difference between the two.

*298. Give an example of determining the resistance of a voltmeter by means of a known resistance.*

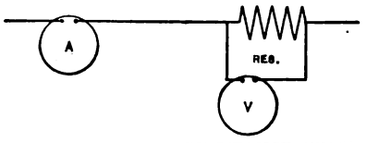
Suppose that the voltmeter reads 125 volts when connected directly across the line, but only 75 volts when in series with a resistance of 10,000 ohms. The resistance of the voltmeter is then: $10{,}000 \times 75 \div (125 - 75) = 750{,}000 \div 50 = 15{,}000$ ohms.

*299. What range of resistances can be measured satisfactorily with a voltmeter?*

It depends largely upon the range and the resistance of the voltmeter. With a Weston 150-volt instrument one can measure from about 100 to 2,500,000 ohms, the greatest sensitiveness and accuracy being for resistances about equal to that of the voltmeter. With one having a range from 0 to 5 volts, one can measure resistances from about 3 to 85,000 ohms.

*300. How can one measure resistance with an ammeter and a voltmeter?*

Connect the ammeter in series with the resistance to be measured and connect the




MEASUREMENT OF RESISTANCE WITH AMMETER AND VOLTMETER.

voltmeter in shunt around it, as shown in the figure. By Ohm's law, the resistance equals the current divided by the voltage.

*301. Give an example of measuring resistance by an ammeter and a voltmeter.*

Suppose the current through one of the field coils of an arc dynamo is 10 amperes, while the voltmeter shows 20 volts when connected around the coil. The resistance of the coil is then: $20 \div 10 = 2$ ohms.

The voltmeter connected around an arc lamp in the same circuit shows 45 volts. The apparent resistance of the arc lamp (including the arc) is: $45 \div 10 = 4.5$ ohms.

*302. What precautions are necessary to insure accuracy when measuring resistance with a voltmeter?*

Be careful that the voltage of the dynamo or battery does not change between the two readings; this can usually be checked by taking a second reading across the line with the voltmeter alone. Be sure also that the voltmeter is not affected by any magnetic field from the circuit being measured. Also be sure that the wires and connections used do not have any appreciable resistance, or that must be considered.

*303. What precaution should be taken when measuring with ammeter and voltmeter?*

Be careful that neither instrument is affected by magnetic field from the other instrument or from any other source. Be careful not to use more current than is suitable for the resistance being measured. Be careful about the connections, especially those at the terminals of the resistance which is to be measured, for if these are not good the voltmeter will read too high. There is a small source of error in the fact that if the voltmeter is connected inside the ammeter, the ammeter measures the current through the voltmeter as well as that taken by the resistance; on the other hand, if the voltmeter is connected behind the ammeter it measures not only the drop through the resistance, but also that through the ammeter, and through the connections. It is usually better to neglect the current in the voltmeter and connect it directly to the terminals of the resistance.

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# Queries and Answers

Can 125 cycle transformers be run with new machines giving 60 cycles? H. T.

Yes, with equal satisfaction. See editorial pages for further details.

How can the negative and positive terminals of a battery or dynamo be distinguished by placing a wire from each in a glass of water? W. H. D.

The negative terminal gives off hydrogen and bubbles more freely than does the positive.

Does it make any difference in the case of a constant potential arc lamp whether the resistance is between the positive wire and the lamp or between the lamp and the negative wire? R. D. C.

No difference whatever.

A small motor with a pole armature will turn half way and then stand still. What is the probable trouble? C. E. K.

In all probability the connections of the coil on one of the poles of the armature are reversed.

How many cells of type "A" Edison-Lalande battery will I require to run motor described in the American Electrician of February, 1897, wound for 6 volts? G. J.

The Edison-Lalande battery gives about 7/10 of one volt with a normal load. Nine such cells connected in series will give 6 volts.

What is the formula for computing the c. p. of incandescent lamps at increased voltages above the normal? S. B. S.

The c. p. varies approximately as the sixth power of the voltage supplied, although this law depends somewhat upon the initial efficiency of the lamp; thus a 110 volt, 16 c. p. lamp would give roughly 17 c. p. on 111 volts, about 18 on 112 volts and so on for a short distance.

I would like to know how to construct a machine that will wind a solid iron ring, such as that in the regulating coils on the back of the G. E. alternating fan motors, taking the wire from a spool without winding it upon a shuttle. W. M. N.

No machine can be built that will do this work, as the spool cannot be slipped through the ring, making it a physical impossibility.

Please state the best way to make a counting machine for counting turns of wire for armature, field coils, etc., when wound upon a lathe. W. M. W.

The simplest method is to use a bicycle cyclometer with a piece of wire fastened to the head stock of the lathe in such a way as to advance the cyclometer one notch each revolution. A few trials will determine the number of hundred turns per mile indicated on the cyclometer.

Can telephone and telegraph messages be sent upon the same wire with a ground return? A. H.

Yes, by connecting in series with each telepgraph instrument, at the terminals between the line and ground, a choke coil, and by shunting around this choke coil and telegraph apparatus a telephone set in series with a condenser. Further information will be given on this subject later.

Given 6 cells of a voltage 1.05 each and an internal resistance of 0.5 ohms each, joined in series and placed on a circuit containing resistance in parallel of 3 and 30 and 300 ohms each, what will the current flowing in the circuit be? W. R.

The current will be almost exactly 1/100 of an ampere in the 300-ohm shunt, 1/10 of an ampere in the 30-ohm, and 1 ampere in the 3-ohm branch, as the e. m. f. of the battery will be pulled down by the internal drop to about 3 volts.

Given a compound-wound dynamo of 50 k. w. capacity, voltage at full load 115, armature resistance hot 1/1000 ohm, shunt resistance hot 25 ohms, drop in series coil 5/10, volt, watts loss in friction 1250, hysteresis loss 300, what is the efficiency of full load? H. S.

The losses at full load are as follows: Armature copper loss 190 watts, series field loss 220 watts, shunt field loss 530 watts, friction loss 1250, hysteresis loss 300 watts, making a total of 2490 watts loss. If the output is 50,000 watts the imput must be 52,490 watts and the efficiency about 95 per cent.

Please inform me as to the cost of running a 15 h. p., 220 volt motor for 10 hours at 10 cents per kw. hour. Would it be 7 1/3 cents per h. p. hour? J. J. M.

Ten cents per kw. hour amounts theoretically to 7½ cents per h. p. hour, but owing to the losses in the motor 10 cents per kw. hour input would amount to about 9 or 10 cents per h. p. output. The cost of running the motor will depend largely upon the load placed upon it. If run continuously at full load for 10 hours at this rate it would amount to $12 for 10 hours.

What form of dynamo should be used in charging a storage battery and why? A. E. C.

A shunt machine only should be used as a series or even a compound machine is apt to have its field magnetization reversed in case it slows down and the storage battery tends to discharge back through the machine. In this case the machine would act as a dead short circuit upon the battery, tending to help its discharge. With a shunt field this cannot occur, as the battery tends to keep the field constantly excited in the proper direction.

In a G. E. 4 ring, 3 phase alternator is there the same voltage between any two of the rings and how should lamps and motors be connected? J. W.

On testing it will be found that there is the same voltage between any two of three of the rings, but that the fourth gives a lower voltage between itself and any one of the other three. Three phase motors should be connected invariably to the three terminals and not at all to the fourth. Lamps should be divided in three different loads connected respectively between one of the three terminals and the fourth, the latter becomes then a common return for three different groups of lamps.

What is the simplest form of incandescent lamp ground detector for 110 volt circuits? W. A. H.

Two 110 volt lamps connected in series across the lines, the middle wire between them being tapped off to ground. In case there is no ground in the system each lamp gets half the voltage, the current passing in series through the two. In case one of the mains becomes grounded the lamp connected to that main is obviously connected between ground and ground and gets no e. m. f., the other one getting 110 volts; thus one goes out and the other shines at full c. p. when there is a ground upon the system. The one which goes out is connected to the grounded side.

Is street lighting a practical success on a 2080-104 volt, 125 cycle, single-phase system using lamps connected with transformers already supplying incandescent lights to private houses? L. B. P.

Arc lights are often run on consumers' premises from the transformers which run the incandescent lights, and with success when the lines and transformers give close regulation. Arc lights drop the voltage badly on poorly regulating transformers. Street lights would probably, as a rule, be too far removed from private transformers for this work, although considerable drop in the leads from the transformer to the light might be allowed to take the place of the resistance usually used in series with the light.

Does it make any difference whether the equalizer is on the positive or negative side of compound-wound machines? Is it necessary to have the equalizer on the negative side of the machines in order to connect them with storage batteries? A. V. S.

It makes no difference which side of the machine the equalizer is connected to except that, of course, it must be connected to the same side the series field is joined to. Many railroad companies connect the series field and equalizer on the negative side of their machines, so as to give a low voltage between equalizer bus and ground. In connection with storage batteries it is only necessary to connect the battery between the equalizer and the opposite pole rather than across the outside terminals, so that in case the dynamo slows down and the storage battery discharges back through it, the current will not pass through the series field and reverse the magnetization of the machine.

Have dynamo machines been built so as to be self-exciting, series, shunt or compound-wound and give direct currents and also alternating currents of any frequency desired? R. C. J.

Yes, an ordinary direct current dynamo can have its winding tapped to collector rings, which will give alternating currents of a frequency dependent upon the speed and number of poles, and of any desired number of phases. Such a machine can, of course be shunt or compound wound on its direct current end, and if desirable, fitted with a rectifier and compound winding for its alternating end. Some railroad companies having long distance lines now use such machines, giving 500 volts direct current for sections of the line near their stations and alternating currents which are stepped up to high pressure and transmitted out to rotary converters in substations for the feeding of the distant sections.

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## THE SAFETY THIRD-RAIL SECTIONAL CONDUCTOR SYSTEM.

On April 12th the first public test was made of a full sized sectional conductor railway installation worked out on the plans of the Safety Third-Rail Electric Company of New York City. The track on which the showing was made is a short section of the Long Island Railroad at Manhattan Beach connecting the Manhattan and Oriental Hotels, with a length of about 2,000 feet; this has hitherto been operated with a steam locomotive and car, connecting with all the trains arriving from New York City, but during the coming summer the traffic will be carried by the new system.

The equipment consists of a "Duplex" convertible car, mounted on Peckham maximum traction trucks fitted with General Electric motors. The third rail is a 65-lb. tee, in sections about 18 feet long, placed midway between the track rails. It is surrounded by a wooden trough placed directly on the sleepers, the rail being supported inside the trough by granite blocks and the trough afterwards filled with asphaltic cement. The sections of the third rail are insulated from each other by artificial granite blocks about 12 inches long. The current is picked up from this rail by two shoes, one under each truck of the car. The automatic switches which connect the sections under the car with the main feeder and again disconnect them when the car runs away from them are of the electromagnetic type, operated by currents sent to them by the car, and may, therefore, be located at any convenient point, or grouped in neighboring structures or vaults.

The general design of the switch is shown in one of the accompanying illustrations. The winding is enclosed in a cast-iron cylinder with a central plunger, which lifts up the main contacts at the bottom of the switch; these consist essentially of a primary contact of laminated copper leaves and secondary contact or following break of carbon to render harmless any arc that may occur. At the top of the switch is an auxiliary break, the purpose of which is described below.

The general method of operation is best shown in the accompanying drawing, where WW represent the wheels of a car running on a track, T, and driven by the motor, M. The third rail is indicated at R, midway between the track rails, and is divided at I and $I_1$ by insulating sections. Every other section of this third



ONE OF THE AUTOMATIC SWITCHES.

rail is blank, that is, it has no connection at any time with the main feeder, the alternate or intermediate sections being connected at proper times through the automatic switches with the source of power. In the illustration the central piece between the insulating joints I and $I_1$ is such a blank section, while that to the left may be connected through the switch, S, with the main feeder, F, and that to the right through the switch $S_1$. with the same feeder. The car takes current from the third rail through the contacts, C and C .

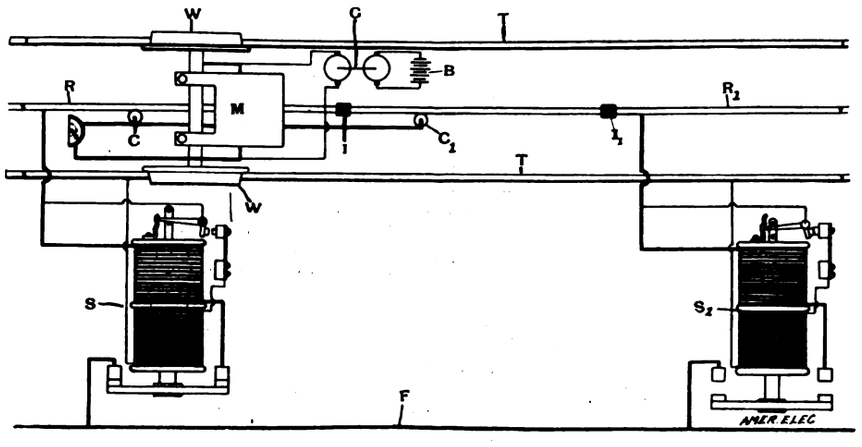



DIAGRAM SHOWING SCHEME OF OPERATION.

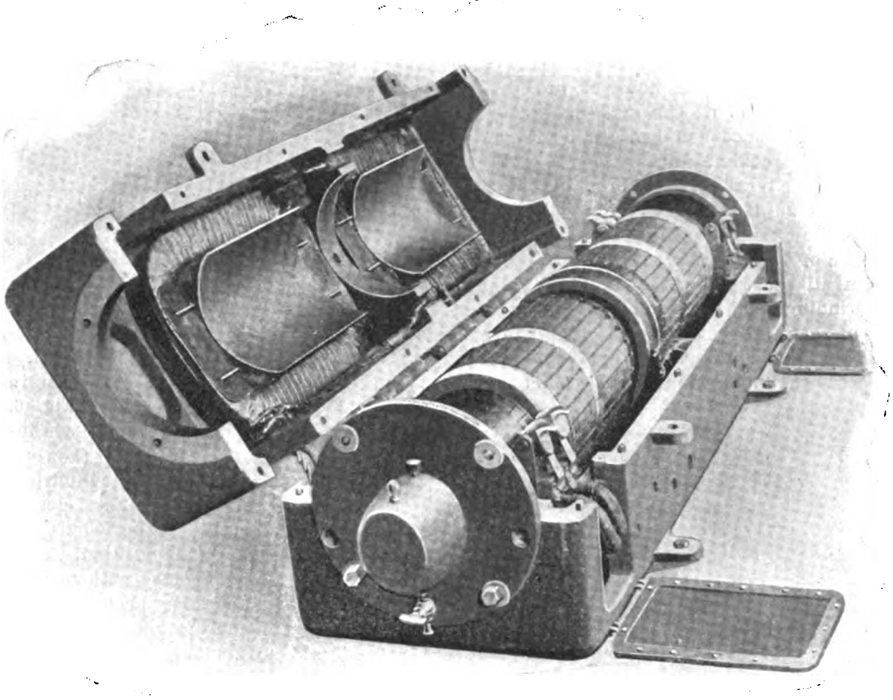
The distinguishing peculiarity of this system is the fact that power house current is used to operate the switches and, although a local source of current exists at the car for picking up the switch in case at any time there is no connection with the main feeder, yet no fourth rail or set of contacts is necessary for transmitting this local current to the switches. This necessitates that the local source of current shall be applied between the third rail and the track rails and therefore that it shall have the full pressure of the current supplied, namely 500 volts. This is ingeniously obtained upon the car by means of a small storage battery working a motor generator, which transforms the low pressure of the battery to 500 volts.

The operation of the system is as follows: Supposing that the car indicated in the diagram is moving to the right, as indicated by the arrow, it is in the position shown taking current from the main feeder through the switch, S, and holding the plunger of this switch in the up or closed position by virtue of the series winding indicated on the upper part of the switch magnet. When the car advances so that the contact, $C_1$, passes beyond the insulating joint, $I_1$, on to the section of the third rail, $R_1$, it introduces into this section current derived from contact, C, which is still on the last live section, R. This current passes through the fine wire or shunt winding on the lower half of the coil of switch, $S_1$, and instantly pulls up the plunger, closing the lower contacts of the switch. The current then has two paths to the car, one through each of the switches, and divides between them in approximate equality. The raising of the plunger of switch, $S_1$, also breaks a small auxiliary contact shown at the top of the switch and connected in the fine wire circuit, but the plunger is held up by the current flowing through the coarse wire or series coil. When the contact, C, passes the insulating joint, I, in the third rail, current no longer comes in through the switch, S, and, both its shunt and series coils being de-energized, the switch drops open by gravity and is ready for the next car, the same cycle of operations being repeated at all the switches as the car passes them.

It is clear that at any time when the current is turned off in the controller from the car motors it will no longer hold up the switches by means of the series coil, and the car will be cut off from the main feeder. In order to again get connection with the power house the storage battery indicated at B, and the motor generator indicated at G, are installed on each car. While the car is running and taking current this little motor generator continuously charges the battery from the main line. When the controller is turned to the off position the motor generator is cut out of circuit, and when it is desired to again take power the first notch of the controller connects the 500-volt side of the motor generator across the third rail contacts and the ground thus giving sufficient current to energize the fine wire winding of the switch or switches connected to the sections on which C and $C_1$ bear and to pull their contacts into the up or closed position. Immediately thereafter the controller is advanced another

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notch, throwing current into the motors, which current comes through the coarse wire windings of the same switches and holds them in the up position, the car running on as explained above. If the



THE MOTOR GENERATOR.

controller is moved to the second notch too quickly before the electromagnetic switch has time to act, the car motors will obviously act as a short circuit upon the motor dynamo, and if moved too slowly from the first to the second notch the switch will obviously vibrate up and down like the make and break device of an induction coil, as it breaks its own shunt winding every time it rises, but it is found that the switch may be made to keep good time with controllers as ordinarily operated.

In the equipment at Manhattan Beach the storage battery consists of ten cells of the 7 V type of chloride accumulator, and from them 20 volt lamps are operated in multiple to light the car. The motor generator is a two-field machine, illustrated in the accompanying figure, ingeniously designed to occupy a limited space, so that it may be placed under the ordinary car seat. The machine weighs about 500 pounds, and is designed for high armature reaction, so that it may withstand the occasional short circuit above mentioned without injury to itself or the battery. The two-field feature is necessitated by the fact that the ratio of transformation should vary from about 500 to 25 volts while the battery is being charged, to 18 to 500 volts while the battery is discharging. This is accomplished by special field windings connected with a contact in the main controller.

The patents on the system have been taken out by Captain John McLeod Murphy, the electrical and mechanical engineer-in-chief of the Company, of which the well known banker, Emerson McMillin, is president. These patents cover broadly the motor generator principle by which 500 volts can be generated on the car without a large number of storage cells and by which a fourth rail or set of contact studs can be done away with as well as several other valuable features.

## THE WAGNER SINGLE PHASE MOTOR.

It is becoming more and more obvious to the central station manager that profits depend on the uniformity of the load, making it necessary for lighting plants to obtain day loads, if possible. The only day load of any consequence is the distribution of power by means of motors, which has proven difficult in the case of single-phase alternating current plants owing to the backwardness of the development of the single-phase motor as compared with direct current or even multiphase alternating current motors.

Although there are many different principles under which small alternating current motors may be built, those of any commercial size may be divided into two general classes—the synchronous and the induction types. The first is practically an alternating current dynamo without rectifier or composite winding. It must be brought up to speed by some auxiliary starting device, such as another motor, and thrown into circuit only when in synchronism and with the proper phase relation, just as one dynamo is thrown in multiple with another. When circuits are changed it is liable to lose synchronism and stop, it always requires an exciter and its field strength affects greatly the regulation. For these reasons it is not adapted for general power distribution in small units from lighting circuits.

The other type is the induction motor with a rotary field analagous to that of the multiphase motor. While a single-phase alternating current will not alone give such a rotary field, the currents induced in the rotating part of an induction motor give a magnetizing force lagging behind that impressed by the winding of the field or primary circuit, to which the single-phase circuit is supplied. When the motor is running, this lagging magnetizing force is carried by the motion of the rotating part to a position at an angle with the main magnetizing force with which it is out of phase, thus giving to a motor with a correctly proportioned stator a true rotating field which makes the induction motor as satisfactory a machine upon single phase as upon multiphase circuits.

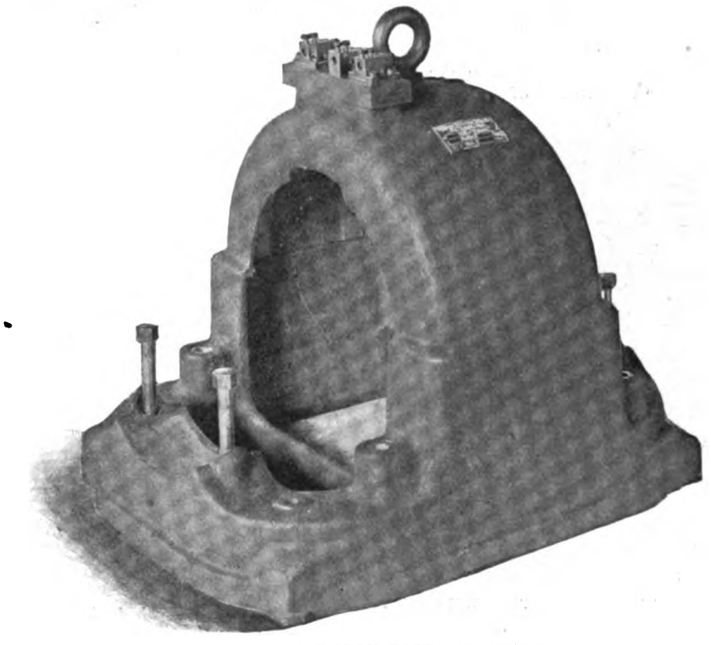


FIG. 1.—THE CAST IRON BASE AND SHELL.

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The only essential difference is the fact that there is in the induction motor fed with single-phase current no rotating field until the motor is running, and hence there is no tendency to start from standstill unless some auxiliary arrangement is supplied to give torque up to a speed at which the rotary field effect will carry the load.

The accompanying figures and the description given below apply to the line of motors made to meet these requirements by the Wagner Electric Manufacturing Company of St. Louis, Mo.

Structurally each machine consists of an enclosing shell of cast-iron, Fig. 1, forming the base and the semi-cylindrical cover; slipped upward into this from below is the field ring, with its winding, shown in Fig. 2, and this is fastened in place by a cast-iron follower, Fig. 3, bolted to the shell. While the field has poles in a magnetic sense, it has no yoke ring with internally projecting polar extensions, such as are found in direct current machines, but consists of a ring of laminated plates slotted on their inner periphery to receive the winding, which is uniformly distributed in these slots. The coils, one for each pole, are hand-wound and laid up spirally, i. e., the two middle slots on each side of the center tooth of a pole are first wound, and from them the wire is carried into the two adjacent slots, one to either side, and so on out until all the slots of a pole are filled, giving what is called the "pancake" winding.

In the field of which the illustration, Fig. 2, was made there are 4 poles, and therefore 4 such spiral coils. The armature of this motor is shown in Fig. 4, from which it may be seen that it closely resembles the armatures of direct-current machines. The laminated core is slotted, the slots, however, running not parallel with the shaft, but at a slight angle, in order that the passage of the armature teeth past the field teeth shall not set up high frequency variations of the magnetization, which would cause screaming. The inclination of the armature teeth allows them to pass gradually across the field teeth much as the rotating blade of a lawn mower crosses the stationary blade. The armature is wound just as is a direct-current armature for the same number of poles, and the coils are connected to a commutator, which, however, in the Wagner motor is of the disk or radial flat type. Two carbon brushes bear against this flat commutator

Three terminals are brought out from the windings of this motor and one side of the circuit may be connected to either one of two of them. One connection cuts in all the turns of the field or primary windings and the other cuts out about 25 per cent. of the turns of each pair of field coils, being termed by the Wagner Company the "loop connection." This throws the whole voltage of the supply circuit across a smaller number of turns, so that the back e. m. f. per turn of wire of the motor must be greater; in other words, the alternating density of magnetism in the iron of the motor must be greater. With this connection the motor will stand heavier overloads and build up its speed against a greater starting torque, but it increases the magnetizing or lagging currents and thereby reduces the power factor. The iron losses are also increased.

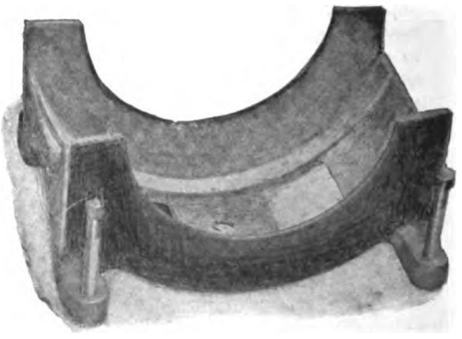


FIG. 3.—THE FOLLOWER.



FIG. 4.—THE ARMATURE.

The starting device is best shown in the cross section, Fig. 6. Here there may be seen inside the spider of the rotor a pair of semi-cylindrical centrifugal weights, closely encircling the shaft in their inner position. They are connected with rods by which they push a sleeve inside the commutator axially along the shaft, the push being resisted by a coiled spring inside the sleeve. When the weights fly out by centrifugal force they move the carbon brushes away from the commutator and slip into contact with the commutator segments a ring of metal which short circuits all the armature or rotor coils.



FIG. 2.—THE FIELD RING AND WINDINGS.

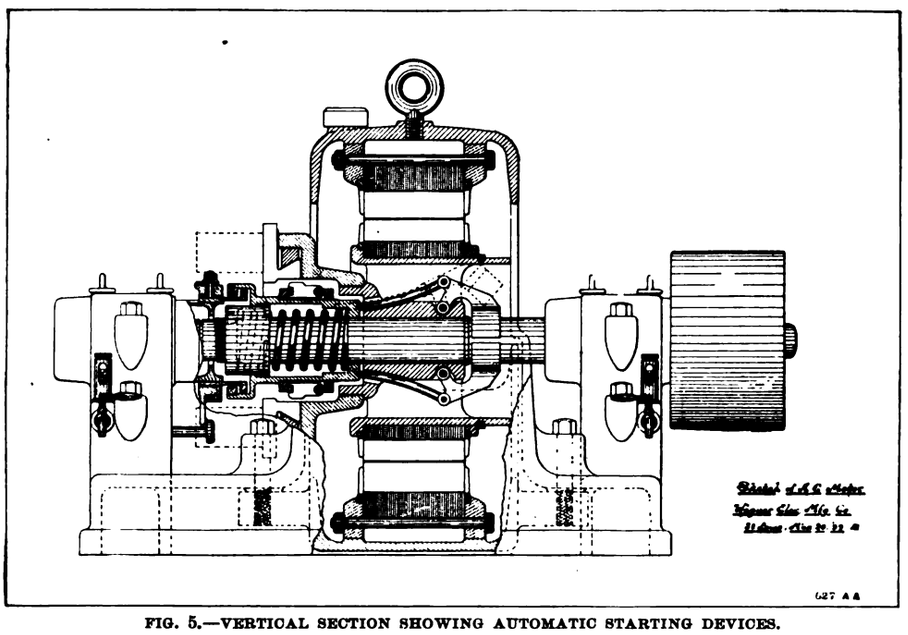


FIG. 5.—VERTICAL SECTION SHOWING AUTOMATIC STARTING DEVICES.

When the motor is started the weights are in their inner position, the commutator is not short circuited and the brushes are bearing upon it. The two

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brushes are connected by a resistance and act to short circuit a part of the commutator. The currents set up in the short circuited windings by the alternating magnetism of the field or stator are repelled by the field itself, giving a torque which sets the motor in motion. When it approaches full speed the centrifugal weights fly out, the brushes are removed from the commutator, the short circuiting collar is brought into contact with the segments and the machine run as a pure induction motor as explained above. By moving the position of the brushes by hand the direction of this initial or starting torque may be reversed and the motor may thus be brought up to speed and run in either direction equally well without any change of the connections.

The number of poles in such motors is directly dependent upon the speed desired. With 60 cycle current, giving 72 alternations per minute, a 4-pole motor will tend to run at about 1800 r. p. m., falling off from this slightly with increased load. A 6-pole motor would similarly run at about 1200 r. p., an 8-pole at 900 r. p. m., etc. With 120 cycles the number of poles must be doubled to give the same speeds.

## INCANDESCENT LAMPS—A DETAILED DESCRIPTION OF THEIR MANUFACTURE.

Although incandescent electric lamps are a very common commodity and have been in use for a number of years, they are still a very delicate and somewhat complicated device requiring the greatest skill in all the mechanical details, an end that can only be obtained by constant watchfulness by experts, and users and buyers have generally little idea how much attention and expense is required in this direction to meet their demands for high grade articles. As there are few factories that give more attention to careful inspection than the one operated under the direction of the Shelby Electric Co. at Shelby, Ohio, the processes here followed furnish the particulars for this story.

The bulbs are purchased by all lamp manufacturers from the glass makers and are all practically bell-shaped, but differ in size, depending upon the candle-power of the lamp. Those for the ordinary 16 c. p. lamp are made with a long, straight neck or tube about ¾-in. in diameter. The transparency is an important factor in the bulb, and for this reason they are all made of the first pourings from the pots of molten glass. The remaining portions, which contain more or less dross, are made into dishes, bottles and other glassware, where transparency is not a necessity. For this reason lamp factories do not make their own bulbs, as there would be too much waste material. The form of the bulb as it reaches the lamp maker is shown in Figure 1. It is first washed and dried by means of rapid circulation of air, so that no spots are left on the bulb. It is then "tubulated" by having a small glass tube fused to the base at one side of the neck, Fig. 2. In some factories the bulbs are tubulated at the large end, but as by this process a tip is left when the tube is removed, the Shelby Company prefers to tubulate at the base, so that one line of their lamps is known as the "tipless bulbs." The company also manufactures on an extensive scale the ordinary tipped lamps.

The next most important element is the filament. The material for this is usually some form of cellulose, but in this factory the particular material is kept a secret, known only to the chemists of the company. In the process of manufacture a fine white thread of the material is formed by squirting it through a die and when dried it has the appearance of an ordinary fine fiddle string. This material is then carbonized by being wound in threads of fifty upon forming blocks which

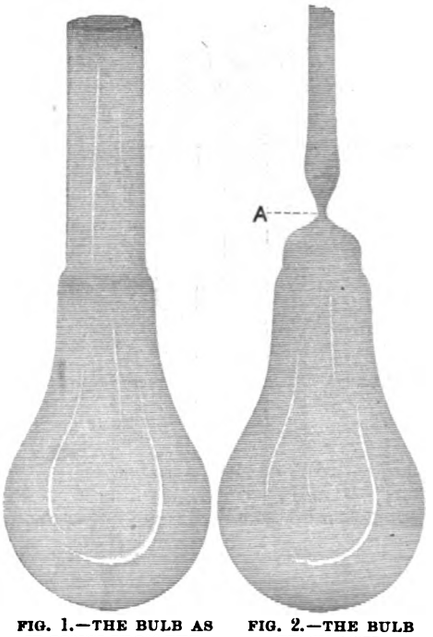


FIG. 1.—THE BULB AS IT COMES FROM THE GLASS WORKS.




FIG. 2.—THE BULB TUBULATED.

are made from carbon. In the Shelby lamp the filament is usually made with three helical coils, and when properly placed upon the carbon forms, the ends of the filaments are fastened by means of paraffine, when the forms, with their contents, are packed in large crucibles and surrounded with pulverized graphite. The crucibles are then covered and sealed and placed in specially designed furnaces, where the temperature is gradually raised by even stages until a high degree is reached, when they are cooled off by the same gradual process until the crucibles can be removed. By this process the filaments are thoroughly carbonized, and when removed from the form they have the appearance of fine steel wire, and the loops maintain their shape. The filaments are now assorted in four or five different grades by means of micrometers which measure to one three thousandth of an inch, and are trimmed to accurate length and made ready for the platinum wire attachments.

The sections of platinum wire are usually about half an inch in length and one end of each is formed into a little tube, first having been flattened and then drawn by means of pliers through a ruby die. The opposite end of the platinum section is then fused to silvered wire, which ultimately forms the leading-in wire to the lamp. Silvered wire is employed by this company in preference to copper, to obviate any liability of oxidation, and is one of the features of the Shelby lamp. The stem, which is another special feature of these lamps, is made by joining the ends of two small glass tubes by a glass bar, making a U shape section. The sections of the silvered wire together with their platinum terminals are now fused within this stem, when they are ready to receive the filaments, and these are attached in the mounting room by inserting the ends of the filaments in the little tubes previously formed on the free ends of the platinum wire. These tubes are then pressed firmly against the filaments by means of pliers, when the stems with the filaments attached are taken to the plating room, where a perfect contact is made between the filaments and the platinum wires by an electric welding or plating process. For this purpose a specially designed machine is operated into which the terminals are carefully clamped, when a current controlled by an automatic regulating device is directed through the section, welding or depositing the plating product. For this operation a small generator is provided and there is a very curious current regulator which controls the current by steps until the contact is perfectly formed.

The stem with this filament goes next to the treating room, where the filament is subjected to a process which is known as plating and which makes it uniform in resistance throughout its entire length. To acomplish this, the filaments are placed, a number at a time, within receivers from which the air is exhausted, and the lamp is lighted by current and allowed to burn for a while in a gaseous carbon compound. In this process, when the proper condition is secured, the current is automatically cut off and directed to the next filament, being controlled by delicate instruments depending on the resistance of the filament. Being thus prepared, the filament with its stem is sealed in the bulb, care being taken that in the process of fusing the stem to the base of the bulb the stems are straight and are attached to the bulb at the proper point. As this process goes on, dents or cavities are formed in the neck of the bulb, which are designed to assist in holding the base, which is attached by means of plaster to the lamp.

As preparatory for the vacuum process the lamps in groups of twelve are attached by means of the tubes, fused to the bulbs as above described, to the forks or prongs of the exhaust pipe of the pumps. As soon as the air is exhausted the lamps are lighted, first by a weak current, which is gradually increased, and as the lamps continue to burn the product of combustion is pumped out, a process which re-

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quires about one hour and three-quarters. In this process a circular hood is dropped over each group of lamps designed to retain the heat generated by the burning, which raises the temperature of the bulbs and assists in expelling the particles of air and gas that have a tendency to adhere to the inner walls of the bulbs.

The vacuum test follows and consists in placing the lamps on the terminal of an induction coil of high potential, which is located in a dark room and which causes the bulb to emit a peculiar glow, showing the condition or degree of the vacuum. If in the test the glow does not show that the vacuum is a "dead black," the lamps are returned to be re-exhausted. Being finished, the lamps are measured to determine their candle-power, volts and watts. For this photometric process a storage battery current is employed.

Following this process the lamps go to the selecting room, where they are sorted as to voltage, candle-power and economy. When ordered they are again tested for vacuum, after which the required base is attached by means of cement, and in this process the terminal wires are soldered in. When dry the lamps are placed upon racks and burned for an hour before they are packed for shipment, and while being burned undergo their final inspection as to appearance when burning with the current required. From this test the lamps go to the shipping room, were they are washed and carefully wiped and dried, after which they are packed in pasteboard compartments in substantial wooden cases. The employees are mostly girls and the average wages are about $1.35 a day, the number of employees being about 180 and the output averaging 5,000 lamps daily. The output includes lamps of every candle-power between four and fifty, in every voltage from forty to two hundred and fifty volts. The entire equipment of the works is up to date and every department seems permeated with the spirit of progress which enables them to claim that the Shelby lamp is the "best on earth."

## TESTS OF CLING-SURFACE.

Some instructive tests of the transmission of power by means of leather belting, with and without treatment with cling-surface, have recently been made under the direction of Prof. R. C. Carpenter, by the laboratory force of Sibley College, Cornell University. The results of the test are shown in the two diagrams represented herewith, in which the abscissae or horizontal distances of both, represent the same tests; in other words, the slip shown for a given initial tension in one diagram corresponds to the horse power for the same tension in the other. An analysis of the results of these tests is best given in the words of Prof. Carpenter, the following being quoted from a letter written by him on this subject:

"The general result of the test with cling-surface shows an increased transmitting power as compared with the same belt in an untreated condition; it also shows an increased arc of contact, and very much less slip. It shows a very high transmitting power when the belt is run extremely loose or with very little tension on the pulleys, the reverse of which is true with the untreated belt. It will be seen from the diagrams that the greatest transmission capacity for the belt treated with cling-surface was found when there was the least possible tension on the belt, and when the belt was running so slack that the sides nearly touched.

"In the test of the same belt not treated with cling-surface the results were quite different, inasmuch as the capacity with very light tensions was practically nothing, and the capacity increased as the tension increased; at no point, however, did the untreated belt have even approximately the same capacity as the treated belt, with the same tension; and, moreover, the treated belt transmitted much more power with a very light tension than the untreated belt with a heavy tension. The test with the belts, treated and untreated, running on wooden pulleys, showed essentially the same characteristics.

"The general results of the tests of the untreated and treated belts when running on iron pulleys is shown in the accompanying diagram, Figs. 1 and 2. In Fig. 1 the horizontal distance show the tension on the belt in pounds per inch of width, the vertical distances show the horse power transmitted per inch of width of belt for a speed of 4500 ft. per minute. The lower line represents the results obtained with the untreated belt; the upper line the results obtained with the treated belt. It will be noted that the lower line continually rises, showing an increase in capacity with an increase in tension; the upper line descends at first, showing a decrease in capacity with increase in tension, and later rises. In no place does the transmitting capacity of the treated belt fall below that of the untreated belt. In comparing the respective results it will be noted that the treated belt has a carrying capacity of 13.8 horse power when the tension per inch of width is 5 pounds, while for the same conditions the untreated belt has no carrying capacity; furthermore, it is noted that the carrying capacity of the treated belt, even at this low tension, is nearly 40 per cent. higher than that of the untreated belt, even when the tension has been increased to 80 pounds per inch of width of belt. The diagram in Fig. 2 shows the arc of contact and the maximum percentage of slip for bolts run both in the treated and untreated condition with different tensions and on iron pulleys.

"In regard to the questions raised as to the preservative qualities of Cling-Surface and to the permanency of the effect produced by its application, the writer would say that our tests have of necessity been of too short duration to give conclusive answers. The general effect of the Cling-Surface is to soften the belt and to put it apparently in the best condition for transmitting power and retaining its good qualities. The surface produced by the Cling-Surface remains apparently unchanged after several weeks of use, and the inference to be drawn is that the material has an effect which continues permanent for some time at least."

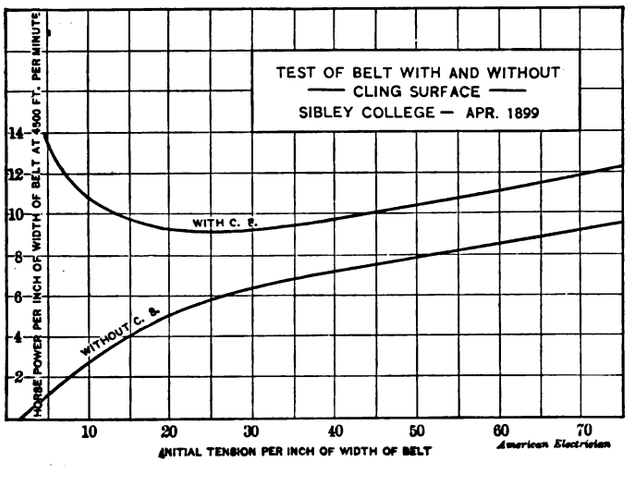



FIG. 1.—VARIATION OF H. P. WITH INITIAL TENSION.

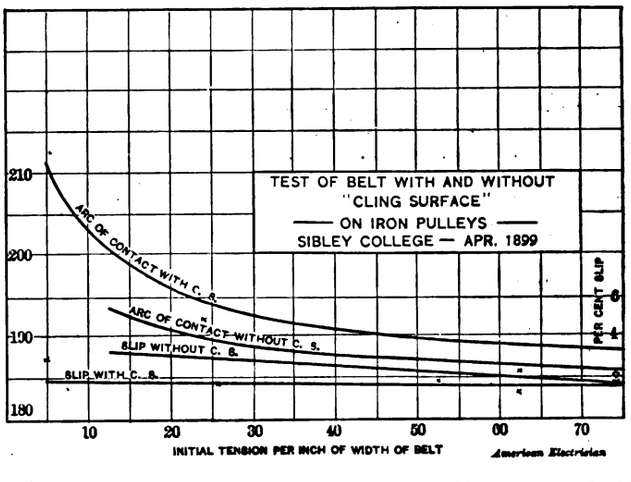


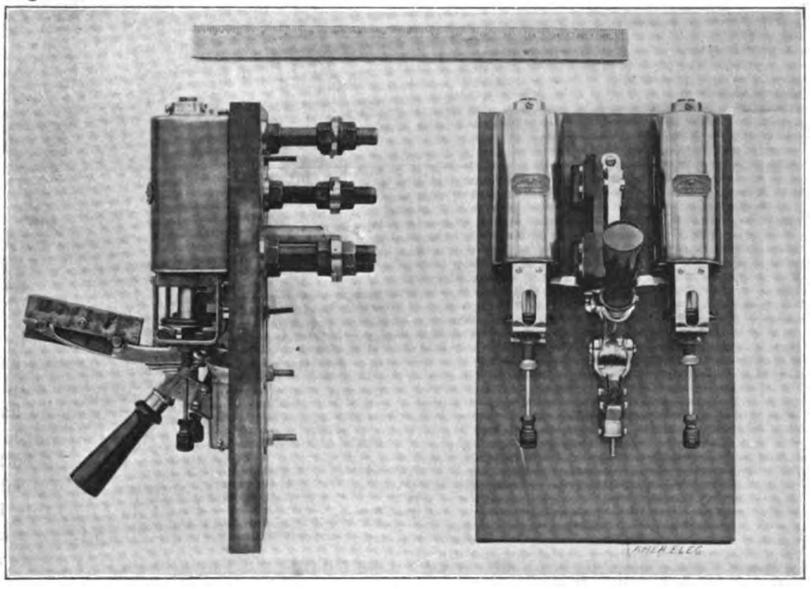

FIG. 2.—VARIATION OF SLIP AND ARC OF CONTACT WITH INITIAL TENSION.

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# New Apparatus and Appliances

### A RELAY CIRCUIT BREAKER.

It has become universally customary to open loaded dynamo or feeder circuits by means of the circuit breakers instead of switches wherever the former instruments are in the lines. While this practice was primarily dictated by laziness, the tripping of the circuit breaker being easier than the opening of the switch, it is commendable, as the circuit breaker is always fitted with following breaks, which are not injured by the arc as are the blades of knife switches.



A CIRCUIT BREAKER WITH RELAY OR OVER VOLTAGE COIL.

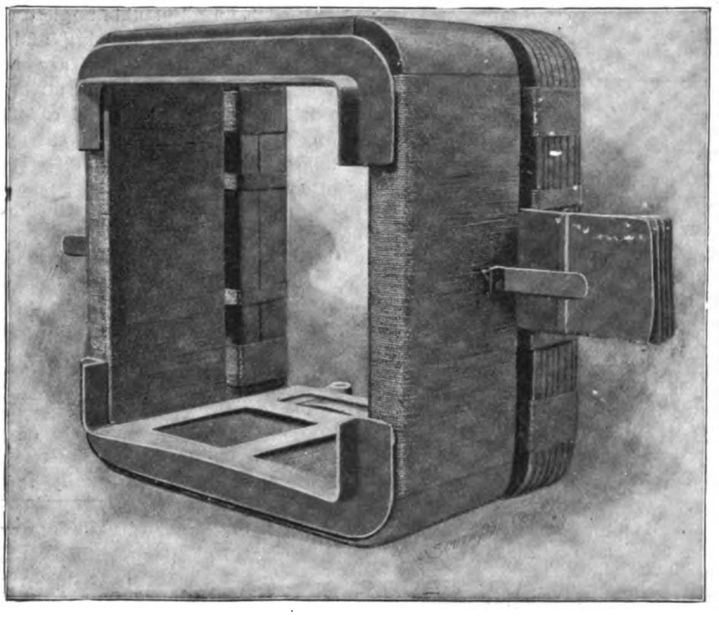
It is often found desirable to open circuits from points distant from the switchboard, either in case of emergency or to save walking to and fro. Several types of electro-magnetic switches have been built for this purpose. A happy combination of the two principles above mentioned is effected in the circuit breaker illustrated in the accompanying engraving, which is made by the Ward-Leonard Electric Co., Bronxville, N. Y. The breaker is supplied with two independent coils or magnets, one connected as usual in series with the line to act on overload, and the other with a finer winding connected across the lines through one or more push buttons at any desired location. Both magnets operate the same latch on a single pole breaker in the middle of the instrument.

The equipment shown is single pole, but can be made double pole by placing another switch at the right of the right-hand magnet, the latches of both switches being tripped by the plunger of the magnet between them. Obviously the fine wire magnet may be kept on permanently closed circuit and adjusted so that it will only pull up its plunger when the voltage exceeds a certain maximum safe limit, thus making the circuit breaker an over-voltage as well as an overload instrument.

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### THE FIELDS OF WESTINGHOUSE GENERATORS.

One of the characteristics of Westinghouse engine type dynamos is the arrangement of the field coils. The field castings are divided vertically and set upon a guide plate, over which they may be moved laterally away from the shaft to allow the removal of the armature or field coils without the necessity of disturbing the outboard bearing or dismantling the engine. This opening of the fields in a horizontal direction is of particular convenience where head room is limited or cranes for lifting heavy weights are not available.



THE SHUNT AND SERIES COILS OF A RAILWAY GENERATOR FIELD.

The shunt and series coils are always separately wound, the series coils, as a rule, being nearer the yoke and the shunt coils nearer the pole. The series conductors are composed of forged copper straps of rectangular section laid up edgewise and kept together by binding ropes at intervals. The shunt and series coils for a 500-kw. direct-coupled railway generator are shown in the accompanying engraving, which clearly indicates the multiple straps by which a good clamped contact can be obtained between coils on adjacent poles and the single straps carrying the shunt current. The coils are, as is there indicated, mounted on two brass skeleton plates, which are secured in place by being bolted to the laminated poles, no extended pole pieces being used.

Any slight inequality of the field strength of these generators which might have serious consequences in parallel wound machines, is automatically corrected by an ingenious invention of Mr. B. G. Lamme. It is obvious that in a parallel wound machine the current may not distribute itself equally between the different paths, one under each pole, from the positive to the negative brushes, but may, if one pole is a little stronger than the others, flow mostly under the strong poles and little, or none at all, under the weaker one. If one pole is considerably weaker than all the others, the current may even be reversed in it and exert a reaction on the field which will further weaken it and cause the path under that pole to act as a short circuit to the rest of the machine. This is particularly likely to occur when the bearings become worn, or from any other reason the armature gets out of alignment, increasing the air gap on one side and diminishing it on the other.

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In the Westinghouse machines the windings are cross connected at points of equal potential, there being two or three such cross connections per pole. The winding under each pole is virtually a synchronous alternating current motor, and these are all connected in multiple by the cross connections above mentioned, thus allowing magnetizing currents to flow from pole to pole to mutually adjust the field strength just as occurs when synchronous alternating current machines are connected in multiple. This prevents the excessive heating which occurs when the current is unequally distributed, as well as the enormous mechanical strains which ensue from unbalanced fields.

A TELEPHONE INDUCTION COIL.

The Varley Duplex Magnet Company, Jersey City, N. J., has brought out a

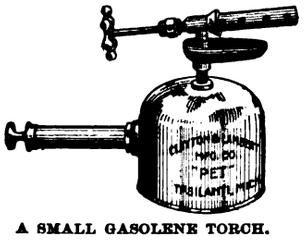


A BOX COIL FOR TELEPHONE TRANSMITTERS.

new box coil possessing several points of superiority over the style brought out over a year ago. It permits the use of a secondary wire one gage number heavier without increasing the external dimensions of the coil, thus diminishing the resistance and improving the efficiency. The screw holes are both in the cover of the box, insuring accurate alignment and a fixed distance between them, one screw passing through the head of the inner bobbin.

A CONVENIENT TORCH FOR SMALL WORK.

The Clayton & Lambert Manufacturing Company, Ypsilanti, Michigan, has put




A SMALL GASOLENE TORCH.

on the market a simple and handy torch shown in the accompanying cut. It is particularly convenient for inside wiring or any small work needing a needle flame strong enough to do light brazing. The tank is spun in one piece of number 18 brass and is fitted with a horizontal air pump, which also serves as a convenient handle. The burner is round and fitted with cleaning out plug.

A DEVICE FOR REMOVING AND CLEANING INACCESSIBLE INCANDESCENT LAMPS.

In theatres, churches, high ceiled hotels, depots, etc., the incandescent lights are, as a rule, very difficult to get at, involving

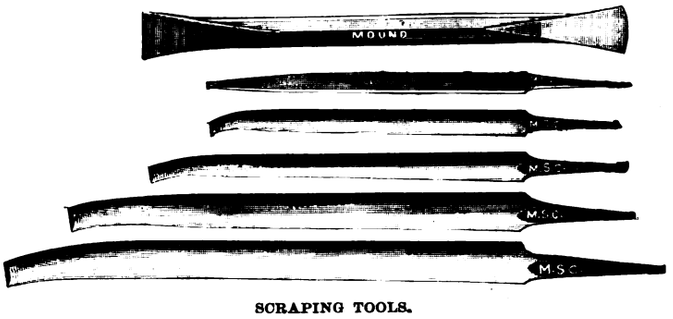


AN INCANDESCENT LAMP MANIPULATOR.

the use of step ladders, which are hard to handle in such places without injury to the furniture. A device for grasping the incandescent lights and removing, replacing or cleaning them from a position on the floor, is made by the Incandescent Electric Light Manipulator Company of Boston, Mass., and consists of a long telescoped pole carrying rubber lined nippers with an adjustable angle and proper arrangements for gripping and turning the lamp. Special tools are made for Westinghouse bases and string lamps. With a little practice and careful handling this device saves a great amount of labor in the moving of step ladders or other apparatus for getting the operator up near to the lamp.

SCRAPING TOOLS.

A convenient set of fine scraping tools for scraping engine bearings, valves, journals, etc., is made by the Mound Tool & Scraper Company, St. Louis, Mo., in sets of six tools of various shapes and sizes, from 8 to 14 inches long, carefully tempered, neatly polished and packed in a substantial and suitably arranged oak case.




SCRAPING TOOLS.

A MONITOR ELECTRIC BELL.

The internal construction of a bell in which the armature is not attached to the hammer lever but is separately pivoted from it, is represented in the cut shown



A MONITOR ELECTRIC BELL.

herewith. A compound lever effect is obtained in this way which swings the hammer through a long arc, giving a quick blow and a very quick return of the hammer from the metal of the bell, producing an unusually clear tone. The bell is struck on its side and not on the edge, as in other makes of this type, this improvement being claimed as giving a better ringing effect. The contact points are so arranged that they slide upon each other for a distance not less than 3/16 of an inch, insuring clean surfaces and reducing the burning. The bell is now made in the 3-inch size, the gongs being of heavy brass, either polished or nickeled. It is listed as the type "Q" sliding contact electric bell by the makers, Rousseau's Electrical Works, New York City.

NON-MAGNETIC WATCHES.

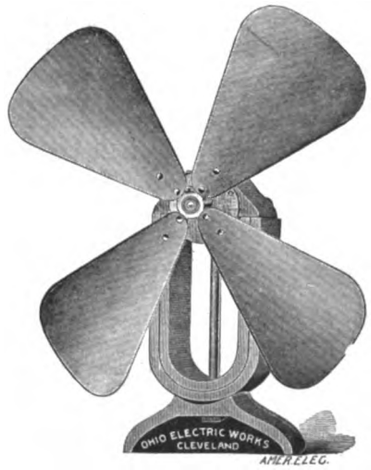
In these days of increasing use of structural steel and of powerful electric currents which give it a permanent magnetization, the owners of watches with steel hair springs constantly find their timepieces disturbed by influences which they cannot account for. The difficulties may not be great, requiring resetting perhaps once a week, but they are annoying and can easily be overcome by using a non-magnetic metal for this delicate part.

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Carl A. Paillard, a watch adjuster of Geneva, Switzerland, has invented a palladium hair spring and compensation balance that is entirely unaffected by magnetic influences. Watches with this improvement are made in all grades and sizes by A. C. Becken, Chicago, Ill. The palladium has other advantages over steel in that it is not rusted even by salt water, and the balance is so perfectly compensated that it is not affected by the heat obtained by placing it on a stove.

### A MAGNETO BATTERY FAN.

It is well known that very small dynamos require a large percentage of their output for the excitation of their fields, but that the same is true of motors of equivalent sizes does not seem to be appreciated. A fan designed to run without waste of energy in exciting the fields of a




A MAGNETO FAN MOTOR.

motor with electromagnets is shown herewith. The field in this case is a double horseshoe permanent magnet cutting down the current consumption for a 10-in. fan running at 1000 r.p.m. to about 1 ampere at seven volts, according to the claims of the makers, the Ohio Electric Works of Cleveland, Ohio.

### INSULATION AND CABLE TESTING GALVANOMETERS.

Messrs. Willyoung & Company, Philadelphia, have recently brought out the new design of D'Arsonval galvanometer shown in Fig. 1. The field is of laminated special magnet steel and the coil proper is contained in a tube which is removable from the magnet in the manner first suggested by Prof. Ayrton and Mr. Mather. Fig. 2 shows tube and coil in section, while in Fig. 3 we have the tube with sheath removed.

The D'Arsonval galvanometer (as opposed to the Thompson type) is probably one of the best instruments for practical use. As now made, it can be extremely sensitive, stable as regards disturbance by mechanical causes, and totally unaffected by all currents except the one passing through it. Magnetic changes in the neighborhood do not worry it.

As shown, the tube, using the word in its largest sense, consists of a rib, R, (Fig. 3), by which are supported the top and bottom torsion heads. A straight fibre above, and helical spring fibre below, furnish torsion and carry the current in and out at the same time. Over the whole slips the sheath, T, which, when in place, is secured against withdrawal by the screw, D (Fig. 3). In case of an accidentally broken suspension one needs but remove the screw D and slip off the sheath, T, to have the entire system, suspensions,

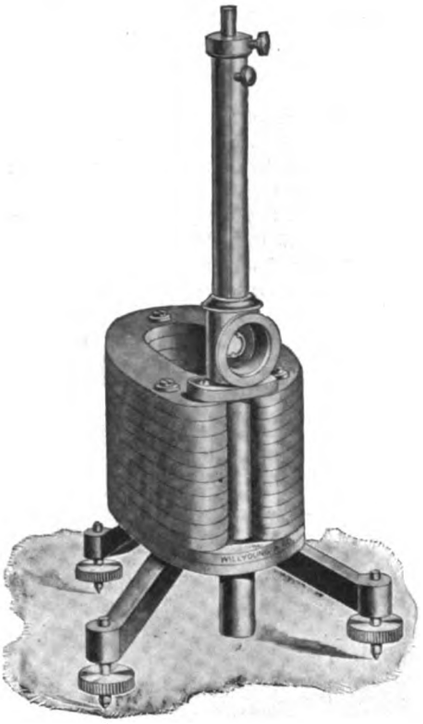


FIG. 1.—AN INSULATION TESTING GALVANOMETER.

etc., absolutely free and accessible. The suspensions themselves are all of standard length and end with bits of No. 22 copper wire, while the torsion heads, as also the top and bottom of coil, are tipped with special connectors, K, so made as to just contain the No. 22 wire; a small set screw is then tightened and holds them securely.

Another feature is the clamp for locking the system against accident and taking strain from the suspension. Through the center of the upper torsion head runs a spindle, or wire, L, at the top of which is a milled head, A. This spindle (Fig. 3), is bent out as shown and finally terminates below in a little fork just under the disc, Q. The head, A, will therefore raise L, and hence the coil by the disc, Q, until jammed tightly against the holed out stop above.

These D'Arsonval galvanometers are furnished with tubes, either dead-beat or ballistic, and as the tubes may be interchanged very quickly and without interference with connections, it follows that an instrument with two tubes is adequate for all the necessities of both insulation and capacity work. The sensitiveness of the tubes may be varied up to 1500 or 2000 megohms, i. e., one scale revision for 100 volts through 150,000 to 200,000 megohms.

Besides supplying these instruments as parts of laboratory outfits, Messrs. Willyoung & Co. are also putting them into portable cable testing sets for street service; in this form they are equipped with a telescope and scale permanently at-

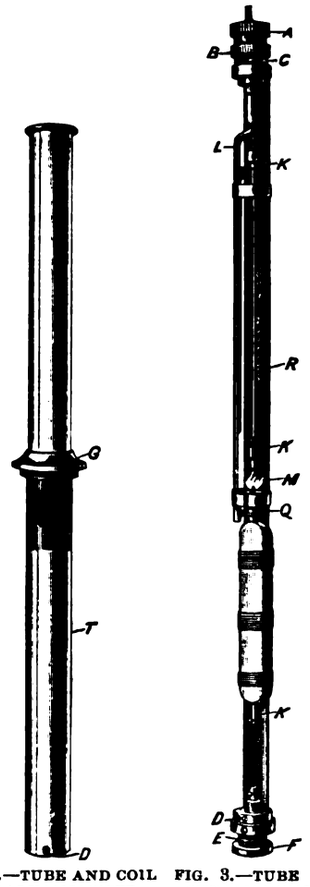
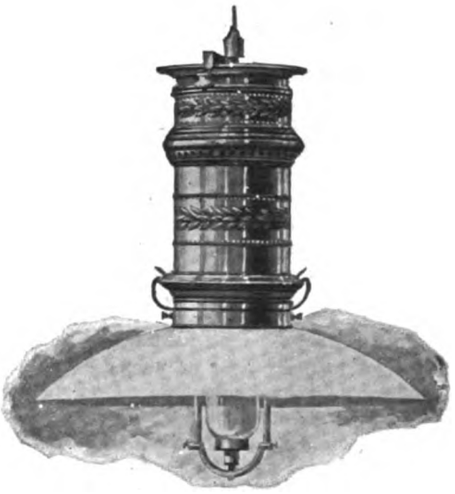



FIG. 2.—TUBE AND COIL OF GALVANOMETER. FIG. 3.—TUBE WITH SHEATH REMOVED.

tached and are mounted in oak or cherry boxes, with sling straps, etc. Mr. James G. Biddle, Drexel Building, Philadelphia, is selling agent for the Willyoung apparatus and will be glad to furnish further particulars to interested parties.

### THE MORRIS ARC LAMP.

The enclosed arc for constant potential direct-current circuits, shown in the ac-



A CONSTANT POTENTIAL ARC LAMP.

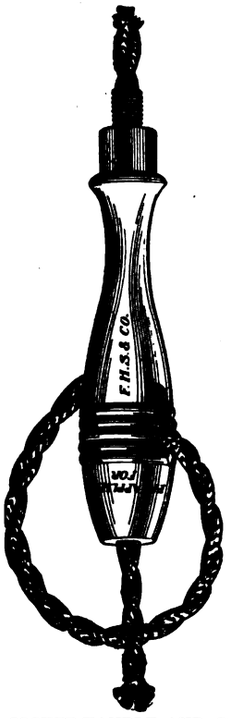
companying cut, is made by the Morris Arc Lamp Company, Chester, Pa. This

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lamp is made in two lengths, one 30 inches over all, giving 100 hours' service with 5 amperes, the other 24 inches over all, giving 60 hours' service with 3 or 5 amperes. The carbon-feeding mechanism consists of a single solenoid concentric with the carbon holder, the plunger lifting the holder by means of a simple washer clutch. Sudden movements are prevented by a dash pot with a graphite piston. Besides the lamps designed to run singly on 110-volt circuits, with 80 volts across the arc, lamps are made to run singly across 220-volt mains, or 2 in series with the same voltage, or 5 in series on railroad circuits.

### A COMBINED SOCKET HANDLE AND CORD ADJUSTER.

The most convenient place for adjusting the cord of a hanging incandescent lamp is naturally at the lamp itself, and the




A SOCKET HANDLE AND CORD ADJUSTER.

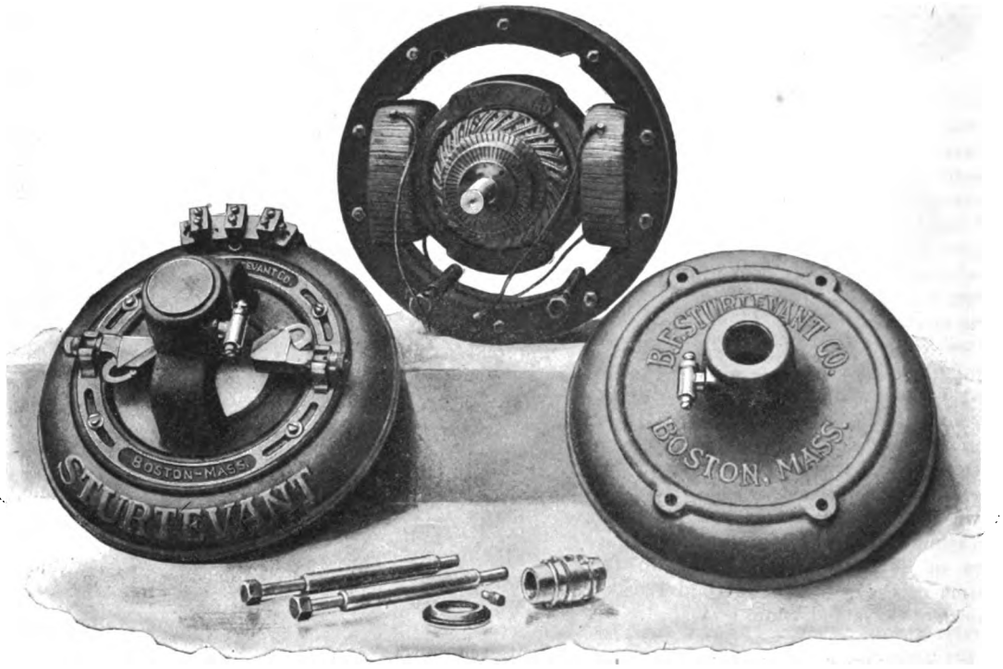
socket handle shown in the accompanying illustration is fitted to perform this function, as well as to give a convenient means of handling the lamp. It also serves to prevent the fraying of the insulation of the wires near the metal parts where a short circuit might occur. This convenient implement is made by Frank H. Stewart and Company, Philadelphia, Pa.

### THE STURTEVANT VENTILATING FAN MOTORS.

The bipolar type of enclosed motor shown in the accompanying engraving is used for direct coupling to propeller fans in all sizes up to and including the 48-inch. For larger sizes 4 and 8-pole types are employed. The motors are entirely enclosed and thereby protected from dust, a valuable point in locations where dust is constantly drawn through them, and are carefully designed for the low losses which are essential in motors without ventilation. The machine is capable of continuous operation for 10 hours with a temperature rise not exceeding 30 degrees F.

The arrangement for supporting the brush holders is a departure from existing methods. The leads to the brushes are brought through from the rear, doing away with any dangling wires. The brushes are of hard carbon and the holders are of a modified reaction type, allowing immediate adjustment when it becomes necessary to reverse the direction of rotation of the motor.

The design of the propeller wheel is the result of an extended series of comparative experiments with different types. The delivery edge is helical, and the form is such that the air is picked up at the inlet edge of the blade at low velocity, and when well under the influence of the blade is accelerated to its maximum velocity with the least amount of slip. As a result, the efficiency is extremely high. The wheel is partially enclosed within a conoidal inlet ring, which decreases the frictional resistance to the entering air. By means of a tripod support the motor is rigidly held in place, and the entire apparatus may be bolted directly to the wall through which the air is to be discharged.




THE PARTS OF A VENTILATING FAN MOTOR.

### INTERCOMMUNICATING TELEPHONE.

There are illustrated in this issue two companion instruments that have been on the market for a number of years, although the designs in which they now appear are a radical departure from all forms and makes of instruments of this class.

The principal change has been made in the wall telephone, as will be noticed by reference to the cut thereof. These instruments are constructed entirely of metal, the base being a jappanned and gold striped iron casting, on which are mounted the other parts. The directory card frame, gong, transmitter top and circular case containing the signal keys are all highly polished and nickeled. All binding posts are avoided. All insulated bushings are specially made of hard rubber. The entire interior mechanism is polished and nickel-plated, insuring ease and continuity of action. The contacts are designed so that a sharp rubbing connection is made in every case.

Special attention has been given to connecting these instruments to the main wires rapidly and securely. Too much attention cannot be given to this point in inter-communicating telephone systems, especially owing to the large number of wires that require attention. A loose or otherwise poorly made connection in any one of the instruments will invariably make itself known after the instruments have been in operation for awhile; therefore provision must be made to substantially and correctly connect the main wires to their respective points. In the instrument illustrated, this is accomplished in a manner that experience covering a good many years has shown to be the best. First, the back of the instrument is placed and fastened in position directly over the main cable. Second, the ends of the wires are brought directly to the proper contact pieces. Third: the front of the instrument, containing transmitter, receiver and all the signal keys, is placed in position, all connections being made automatically by this operation.

The desk instrument illustrated is the well known type manufactured by this company. Some of the more recent improvements in the construction of this

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instrument are the following: First: the entire interior mechanism is polished and plated, giving a smoothness and freedom to the several parts that could not be obtained otherwise. Second: the instrument is not grounded, as is common practice in the Bell Telephone Co.'s apparatus, and other similar instruments. The transmitter is entirely insulated from the outside case in every way. Special provision is made to carry the two wires by the adjustable joint without having any loose wires exposed. All the instruments shown are equipped with the company's new transmitter, in which no wood or other substance that deteriorates is used. The transmitters are of special design and are made by special machinery, insuring uniformity.



THE DESK SET.



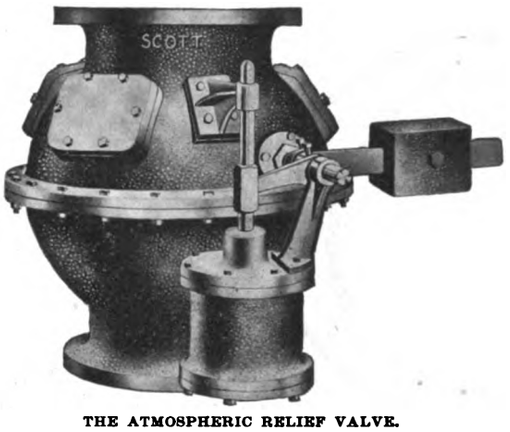
THE WALL INSTRUMENT.

The foregoing instruments are manufactured by the Allen-Hussey Company, having its main offices in Chicago and New York, which makes a specialty of interior and inter-communicating telephone systems.

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TWO SCOTT VALVES.

The accompanying cuts illustrate two of the valves shown in the new catalogue of the Roe Stephens Manufacturing Company of Detroit. Some of the important features claimed for the Scott "pop" safety valves are: The adjustable screw threaded ring, with angular face, by which the valve is adjusted to loose any desired pounds, or fraction of a pound pressure of steam, and by which there is a constant pressure of steam held on the valve seats while blowing off, thereby preventing all abrasion and wear of seats and consequent leakage; the device by which the inequality of pressure of spring is overcome; and transmitted to the axis of the valve, thereby preventing all friction and liability of valve to cock or tilt, and consequent leakage and cutting of seats; the construction of the lock-up, which is simple and effective, and precludes any possibility of the valve being tampered with.




THE ATMOSPHERIC RELIEF VALVE.

The second illustration shows the Scott water sealed exhaust relief, or back-pressure valve. This valve is constructed to operate in exhaust mains between the low pressure cylinder and the condenser, and is so designed that should the condenser fail to operate and a back pressure form, the valve will automatically open, allowing the steam to escape into the atmosphere. All possible leaking of air which would tend to destroy the vacuum in the condenser is obviated by the water seal. This valve can be regulated to open at any desired pressure, and is noiseless under all circumstances while in operation, when weight is properly adjusted and air cushion regulated. It can also be used in connection with exhaust steam heating, and is so constructed that any amount of back pressure can be carried for this purpose. It is made in all sizes from 4 inches to 16 inches.

Special attention is also called in this catalogue to the Scott extreme high pressure gate valves. These valves will stand a working pressure of 300 pounds, and are tested to 1000 pounds hydraulic pressure. They are made of the best material. The seats in the iron body are screwed in and are interchangeable. The disks are wedge shaped, solid, or double cylindrical wedge, as desired. They have a ground joint under end of stuffing box, so they can be packed when full open. They are furnished with flanged or screwed ends with by pass and gearing, when so ordered.

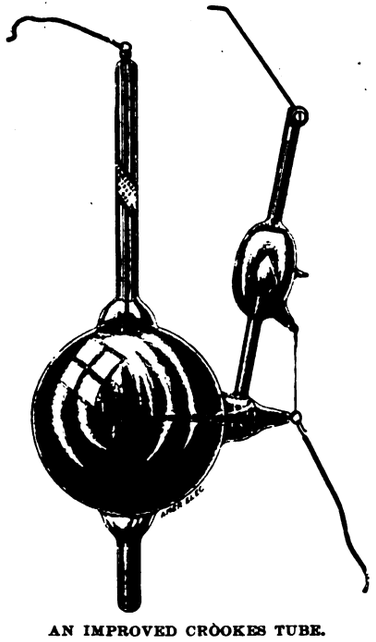
A SELF-REGULATING X-RAY TUBE.

All who have used Crookes' tubes know the general effect which continued use exerts whereby the vacuum is increased until it finally becomes such a high insulator that no more current can be forced through the tube without a strain that punctures or breaks down the glass. Several devices have been gotten up to overcome this difficulty, generally involving the use of an auxiliary or branch tube containing a metal which will give off vapors and reduce the vacuum when heated.




THE "POP" SAFETY VALVE.

The accompanying figure shows a tube arranged so that the heating is automatically effected as soon as the resistance rises too high, so that the tube automatically restores its own proper vacuum. This is accomplished by means of a branch tube containing a small bulb, which, in turn, contains potash, which will give off suitable vapors when heated. The bulb is exposed to a cathode in the auxiliary tube which is exhausted to a low Crookes' vacuum, the corresponding annode being in a shunt circuit around the main tube.

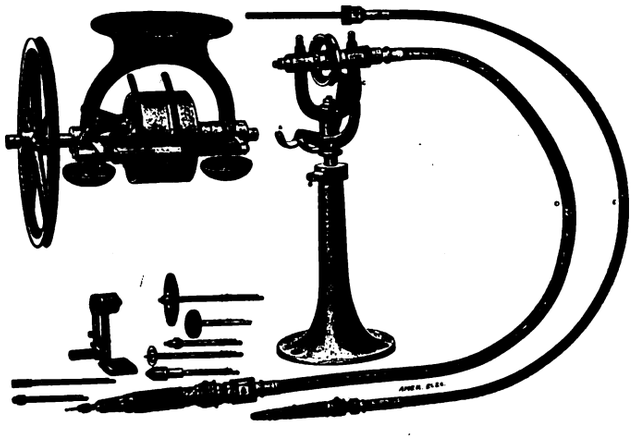


AN IMPROVED CROOKES TUBE.

When the resistance of the latter becomes too high, the discharge passes

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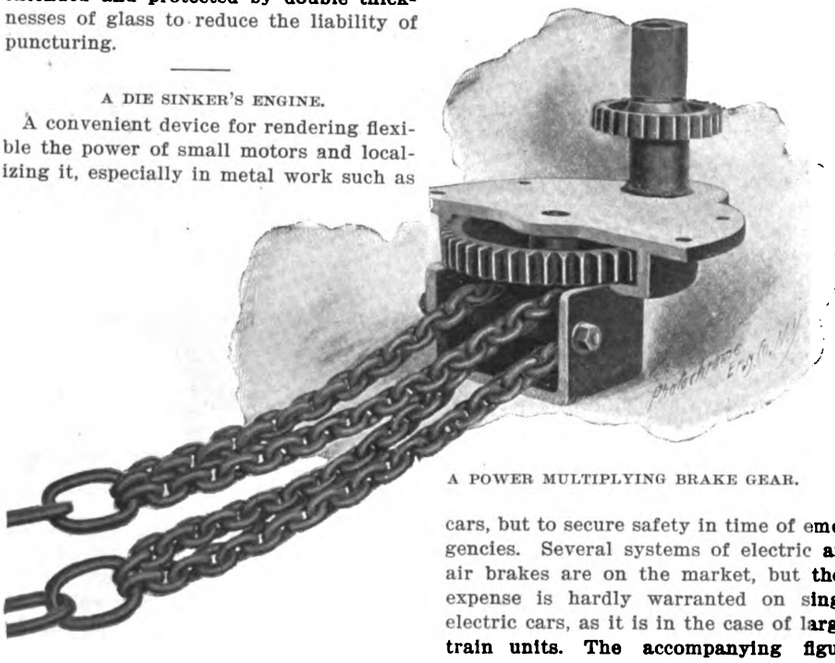
through this shunt circuit, bombarding the bulb with cathode rays, heating the potash within it and thereby reducing the vacuum in the main bulb. By adjusting the spark gap of the shunt circuit the resistance of the main bulb at which the current will take the shunt circuit can be changed and the degree of exhaustion changed with it, so that the tube can be readily changed for X-ray penetrations of different substances. The main bulb is about 4½ inches in diameter, and bears a crushing pressure of over 700 pounds, in spite of which it is less than 1/64 in. thick, an important factor, as glass is partially opaque to X-rays. The larger diameter gives a low heating of the glass and provides a larger surface for the deposit of the aluminum which is torn off from the cathode. The cathode terminals of both the main tube and regulator are extended and protected by double thicknesses of glass to reduce the liability of puncturing.



A FLEXIBLE SHAFT ENGINE.

### A DIE SINKER'S ENGINE.

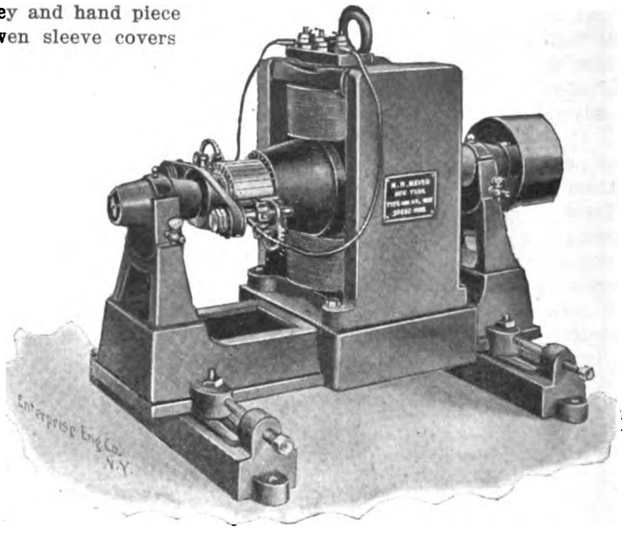
A convenient device for rendering flexible the power of small motors and localizing it, especially in metal work such as that of die sinkers and mould cutters, is shown in an adjacent figure. As the reader will instantly see, it is an adaptation of the principle employed in that terror of the dentist's patient, viz., the dental engine; and is made by the S. S. White Dental Manufacturing Company of Philadelphia. The flexible arm, which is the main feature of the engine, consists of a tempered steel wire cable, so arranged that it maintains its tension without straining or uncoiling, with rigid ends for the attachment of pulley and hand piece or tool carrier. A woven sleeve covers and protects it throughout its length. It gives great freedom and extreme delicacy of manipulation with absolute control of the power and of its direction of operation, factors almost as valuable in fine metal work as in the dental office.



A POWER MULTIPLYING BRAKE GEAR.

### THE STERLING SAFETY BRAKE.

With the constantly increasing weights and speeds of electric cars, improved methods of braking are necessary, not only to reduce the labor of handling the cars, but to secure safety in time of emergencies. Several systems of electric and air brakes are on the market, but their expense is hardly warranted on single electric cars, as it is in the case of larger train units. The accompanying figure shows an improved hand brake made by the Sterling Supply and Manufacturing Company of New York City. The device consists of a spindle shaft socketed to the handle staff and geared to a double sprocket wheel in the ratio of 5 to 2, thus multiplying the motorman's power. The double sprocket wheel carries two continuous chains, so that should one break the other takes up its work instantly and the wear is distributed, increasing the life of the chains. With this device it is not necessary for the motorman to use the foot dog except in case of emergency, as the leverage secured by the gearing enables him to easily hold the brake by hand.



A BIPOLAR IRONCLAD DYNAMO.

### THE MAYER DYNAMOS AND MOTORS.

The illustration above shows a view of an improved direct-current dynamo or motor, made by the Maxwell M. Mayer Electric Company, New York. The machines are of the bipolar, ironclad type, the whole magnetic circuit being a single, open-hearth steel casting. This is bolted to a cast-iron base, to which are cast the pillow-block supports. These are bored at the same time as the pole-pieces, securing in this way the correct alignment of the bearings and armature. The field coils are wound on metal spools. In the armature mica insulation is employed throughout. Tempered copper commutators of large size and bearing surface and carbon brushes are used. These machines are built in sizes of one, two, three and five horse-power, and are constructed for hard and heavy service.

## NEW BOOKS.

Electricity in Town and Country Houses, by Percy E. Scrutton. Second Edition. London. Archibald Constable & Co. 148 pages. Illustrated. Price $1.00.

This is an elementary work of value more to the owner of town and country houses, who is in doubt as to what system of lighting to install than to the engineer who is, as a rule, acquainted with the general propositions the book contains. It is, however, of some interest owing to its description and illustration of English details, which differ from those on this side of the water.

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The Universal Electrical Directory. London. H. Alabaster, Gatehouse & Co. 1182 pages. Price, 6 shillings.

The 1889 annual issue of this valuable directory contains a total of 25,464 names, approximately 16,070 more than were contained in the directory of 1898. Much financial information is given, and telegraphic addresses and local telephone numbers have been added, the various new features in creasing the size of the directory by 64 pages.

Small Accumulators, How Made and How Used. By Percival Marshall. New York, Spon & Chamberlain; 80 pages, illustrated. Price 50 cents.

This small manual is an elementary hand book for the use of amateurs and students, and the first of a series of popular scientific works for electricians and engineers. This book is particularly adapted for those seeking the first rudiments of information on this subject, rather than for experts in storage battery work, owing to the fact that it is made up largely of the answers to questions written to the author as the editor of the "Model Engineer and Amateur Electrician."

## LEGAL NOTES.

ELECTRIC SNAP SWITCHES. — The United States Circuit Court of Appeals at Boston has reversed the decree of the Circuit Court in the case of the Hart & Hegeman Manufacturing Company of Hartford, Conn., vs. the Anchor Electric Company et al., alleging the infringement of a patent granted to Gerald W. Hart. The Court of Appeals sustains the Hart patent and orders the case remanded to the Circuit Court for further proceedings.

## PERSONALS.

DR. S. S. WHEELER, president of the Crocker-Wheeler Electric Company, recently returned to New York City from a visit to Havana.

MR. GEO. J. JACKSON, secretary of the National Conduit and Cable Company, has returned to New York City after a short absence in Europe.

MR. F. A. LARKIN, New York manager for the E. P. Allis Company, of Milwaukee, Wis., has returned from a short business trip in Europe.

MR. W. A. STADELMAN, New York manager for the Brown Hoisting and Conveying Machine Company, of Cleveland, Ohio, has returned from Yucatan, after a month's trip in the tropics.

W. J. CLARK, general manager of the General Electric Company's foreign department, sailed on the Etruria for Liverpool recently. He will remain abroad four months, to complete the organization of his department and to look after the installation of General Electric apparatus in London, Bristol and Dublin.

Mr. C. S. KNIGHT, formerly of the Fort Wayne Electric Corporation, has been elected vice-president and general manager of the Siemens & Halske Electric Company of America. It is understood that a number of other former members of the Fort Wayne Company's staff will join forces with Mr. Knight. The appointment of Mr. Knight is by many taken to indicate the inauguration of a more vigorous business policy on the part of the company, which has the use in America of all the data, patents and designs of the parent company in Berlin. The latter owns the most extensive electrical works in the world and does a more comprehensive electrical business than perhaps any other establishment the world over, as it manufactures a complete line of power and lighting apparatus as well as telephone, telegraph, submarine cable and other signaling equipments and supplies. The American company has hitherto but touched upon this wide field. Mr. Knight was connected with the Pennsylvania Railroad until 1881, joining the Fort Wayne Electric Company in 1886. He has been since 1894 a director of the Fort Wayne Electric Corporation, which has handled the business under contract with the receiver of the original company.

## TRADE PUBLICATIONS.

THE ELECTRIC APPLIANCE COMPANY, Chicago, Ill., has issued a revised price list of pole fittings, telephone wire, lamp cord, speaking tubes and cut outs.

THE METROPOLITAN STEAM BOILER COMPOUND MANUFACTURING COMPANY has issued a circular of testimonial letters from users of the Metropolitan compound for cleaning steam boilers.

THE UNITED CORRESPONDENCE SCHOOLS of New York City has published a book of testimonials entitled, "What Students Say," showing the appreciation of those who have taken its courses.

THE GARTON-DANIELS ELECTRIC COMPANY, Keokuk, Ia., has distributed a number of slips pointing out the necessity for lightning arresters on railway cars and railway overhead lines, and calling attention to the good points of Garton-Daniels' arresters in these locations.

THE NOVELTY ELECTRIC COMPANY, of 50 North Fourth Street, Philadelphia, Pa., has issued a catalogue No. 16 of house material, listing practically all the interior fittings for bells, gas burners, telephone instruments, etc., and also a special catalogue covering the fan motors which it carries.

JAS. M'CREA & COMPANY, of 1113 South Canal Street, Chicago, Ill., report that they have received more unsolicited testimonials of their climax steam joint clamp for repairing leaks where pipes are screwed into fittings from electric light and street railroad power plants than from any other one industry.

"THE AMERICAN TELEPHONE" is the name of a publication of which number 1 of Vol. 1 is dated April, 1899. Although nominally a monthly periodical devoted to the interests in general of independent telephone associations, it is evidently published in the interest of the American Electric Telephone Company of Chicago.

THE SPRAGUE ELECTRIC COMPANY has circulated a folding picture of a yachting scene made up after the style of the old-fashioned valentine, representing several yachts in full sail and intended to convey the idea that a Lundell motor never gets becalmed. The illustration should certainly appeal to the children.

THE ELECTRIC STORAGE BATTERY COMPANY has issued a circular abstracting some of the vaulable information given in the paper on "Latest Progress in the Application of Storage Batteries," read by Mr. Joseph Appleton before the meeting of the New York Electrical Society in January.

THE ELECTRIC GAS LIGHTING COMPANY, 195 Devonshire Street, Boston, has issued a small catalogue entitled, "A Few Specialties in the Line of Electrical House Goods." Among them are the star electro-mechanical gong, as well as various types of switches, push buttons, indicators, bells, etc., suitable for interior work.

THE LYNN INCANDESCENT LAMP COMPANY, of Lynn, Mass., has published a neat little pamphlet pointing out the fact that about $20,000 every month is simply thrown away in the United States by breaking up incandescent lamps and throwing away the glass, the metal base and the platinum wire, simply because the carbon filament is broken, and mentions the fact that 3 cents per lamp means $7.50 per barrel.

THE NATIONAL INDIA RUBBER COMPANY, Bristol, R. I., has issued a new catalogue of the N. I. R. & Paracore wares and cables made by its electrical department. The catalogue contains the proceedings of the special committee of the Underwriters' National Electric Association, constituting the improvements in the national code, which will make it of particular value to wire users who have not as yet become acquainted with all the details of these changes in the code.

"THE WILKINSON STOKER" is the title of a handsome catalogue published by the Wilkinson Manufacturing Company, of Philadelphia, Pa., describing the Wilkinson automatic mechanical stokers and smoke preventors, as well as several other specialties manufactured by the same company, notably the Wilkinson patent condenser and valveless pump, the Wilkinson trunk engine, the vertical archimedean-screw coal lift, the Wilkinson "land engine" ejector condensor and Wilkinson's paragon metallic packing.

THE PETITE ARC LAMP has been handsomely illustrated in a recent catalogue issued by the Western Electric Company. The Petite Arc Lamp is made in a number of different styles, so that it is suitable for use under different conditions. In the catalogue can be found some valuable information regarding the care and operation of enclosed arc lamps. As the Petite Arc Lamp is suitable for street railway plants, power circuits and isolated plants, these catalogues are valuable to those connected with installations of this kind.

DIRECT CONNECTED RAILWAY GENERATORS is the subject of a bulletin issued by the Westinghouse Electric and Manufacturing Company, superseding an older bulletin on the same subject, with the latest up-to-date descriptive matter and illustrations. The bulletin illustrates one of four 800-k.w. engine type generators in the power house of the South Side Elevated in Chicago, as well as an 800 k.w. machine used by the Consolidated Traction Company in Pittsburg. It also describes the method used by the Westinghouse Company for balancing the magnetic circuits of parallel wound machines.

THE CUTLER-HAMMER MANUFACTURING COMPANY, of Chicago, Ill., has issued a perpetual catalogue on rheostats, consisting of a convenient binder in which may be fastened properly punched sheets listing the various types of motor starters made by the company whenever these sheets are printed and sent to its customers. Among the devices of recent design listed in these sheets is the C. & H. pressure regulator, which consists of a diaphragm supporting a weighted lever, which in turn opens or closes with a snap the circuit of the solenoid of the C. & H. self-starter. Sheet No. 72 also shows the reversing switch for electric elevators designed for use in connection with the same self-starter.

THE RACINE HARDWARE COMPANY, of Racine, Wis., has issued a catalogue describing the Racine Automatic Engines. This company's specialty in steam engine work consists of vertical, high-speed, single-valve, shaft governing engines, made in sizes from 2 to 37 H.-P. The valve is a simple form of piston valve. The governor is of the Rites inertia type. All engines are fitted with an outbearing beyond the fly wheel secured to an extended base, giving additional support

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and stiffness to the crank shaft. The machines are well adapted to the running of isolated electric light plants, particularly in cramped locations, where their high speed of about 400 r. p. m. fits them for direct coupling to small generators of standard design.

THE WESTERN ELECTRIC COMPANY, of Chicago, Ill., has published a bulletin under date of March, 1899, on the Stanley lighting transformers which it carries as western agents. One of the good features of these transformers as there pointed out is the fact that all sizes are made for the same regulation, so as to maintain an evenly distributed e. m. f. in all installations and to facilitate the running of transformers in multiple, as where two or more transformers of different drop with increased load are operated in parallel the one having the best regulation will tend to take more than its share of the load. The Western Electric Company also carries in stock Stanley alternating current motors for any standard voltage and frequently from ¼ h. p up to 10 h. p.

THE SHAW ELECTRIC CRANE COMPANY, Muskeegon, Mich., has issued an illustrated catalogue of electrically operated cranes that on account of the beauty of its illustrations and the completeness of its descriptions deserves a place in scientific libraries. The catalogue illustrates and describes various types of bridge cranes, from the mammoth 80-ton double trolley equipments of some steel works and the 70-ton single trolley of the Watervliet Arsenal down to the comparatively small types used in central stations. A crane of particular interest to those owning power stations is that built for extra slow speed and therefore fitted with small motors, high speeds and large motors being unnecessary where the crane is not in constant use. This crane is also fitted with wire rope instead of chains, which reduces the size and weight of the trolley.

THE SPRAGUE ELECTRIC COMPANY, New York City, has issued another of its characteristic catalogues, this one describing the 1899 Lundell fan motors. As usual the catalogue is a striking and attractive piece of work, the general scheme of its finish being white and gold on green. Some interesting anecdotes are given of the use of Lundell fan motors, one of them being as follows:

An officer of the "Amphitrite" states that had it not been for the Lundell fans on board of his ship, as well as on board of the "Terror," "Miantonomah" and "Puritan," during the cruise in the Carribean Sea, the mortality among the men would have been distressingly increased. The thermometer in the ward rooms and steerage more times than not registered above 115 degrees. In the engine room the temperature was usually above 135 degrees and in the fire room 140 to 150 degrees. Fans were distributed in these various locations, as well as in the ward rooms and officers' staterooms.

THE ELECTRIC STORAGE BATTERY COMPANY, of Philadelphia, Pa., has issued circular No. 49, dated April 3, describing and illustrating the Hartford battery station of the New York, New Haven & Hartford Railroad. As traction engineers will remember, the third rail line of the New York, New Haven & Hartford Railroad, running from Berlin to Hartford, is supplied from a power station at the former end and current is taken from it at Hartford to light the railway station and adjacent buildings. The railway voltage varies all the way from 200 to 550 volts and these extreme fluctuations, of course, tend to transmit themselves through the motor generator to the lighting mains. To keep a regulation sufficiently accurate for incandescent lamps in the latter service a storage battery of 62 cells is installed. In order to prevent the fluctuations of the third rail circuit from affecting the storage battery too severely the motor of the motor generator set is wound with special compound coils so connected that when the third rail voltage falls and the battery tends to discharge power back through the motor generator, it weakens the field of the motor and tends to maintain the set at constant speed and vice versa.

## BUSINESS NEWS.

THE FISCHER EQUIPMENT CO. of Chicago has built an electrically driven ambulance for the Michael Reese hospital of that city.

OUTDOOR SUMMER LIGHTING.—In order to meet the demand for decorative lighting the Western Electric Company has placed on hand a large supply of weatherproof sockets.

THE ELECTRICAL ENGINEERING PUBLISHING CO., publishers of "Electrical Engineering and Telephone Magazine," has removed its offices from the Monadnock block to the Marquette building in Chicago.

MANNING, MAXWELL & MOORE, the well-known dealers in railway machinists' supplies, move on May 1st to far more commodious quarters in the new Singer Building, 85 Liberty Street, New York City.

J. JONES & SON, New York City, sell fans for use on both lighting and battery circuits, the latter complete with battery outfits. Few, if any, makers carry both styles, but users and local dealers can obtain both from one source by giving their orders to this house

LARGE ISOLATED PLANT GENERATORS.—The Great Northern Hotel, of Chicago, Ill., which for many years has been supplied with current from the central station mains, has recently transferred its load to its own plant, which consists of three 150-k.w. Western Electric generators.

A LARGE PUMPING ENGINE of the crank and fly wheel type has been ordered by the Water Commissioners of Dunkirk, N. Y., from the Snow Steam Pump Works of Buffalo, N. Y. The engine will have a capacity of four million gallons, and will be fitted with Corliss valve gear, controlled by a new design of governor.

THE WESTERN ELECTRIC COMPANY, in its manufacture of fan motors, not only looks after the balancing of the armatures, but also weighs the fan blades and inspects and balances the fans independently of the motors before assembling. This careful attention to detail is one of the reasons why the Western Electric fan motors are so quiet and satisfactory.

THE CONTINENTAL IRON WORKS of Brooklyn advocates the use of internally fired boilers for land as well as marine purposes, and is pushing the Morison suspension furnaces for use in electric light and power plants. The works recently issued an illustrated catalogue of boilers fitted with these furnaces, giving complete drawings showing details of construction.

THE STROMBERG-CARLSON TELEPHONE MANUFACTURING COMPANY announces that it has not, as has been reported, been a party to the proposed amalgamation of the independent telephone interests. Having a complete public exchange apparatus, a multiple switchboard, a central energy system, an inter-communicating system and a combined police signal and telephone system, the company naturally feels that it can safely remain independent of the proposed independent consolidation and profit thereby.

THE STAR BRASS WORKS, Kalamazoo, Michigan, have recently received some testimonial letters which speak most highly of the hard brass trolley wheel made by them. The Mt. Clemens Fast Line of Detroit, Michigan, reports that it has run one 29 days on a car drawing 100 amperq and running at 48 miles per hour, the car mileage being about 250 miles per day, with the bushing still as good as new. In another case the wheel ran through sleet and ice that burned out the harps and bushings of other wheels constantly.

A CASE OF SAVING BY MEANS OF MECHANICAL DRAUGHT.—The United States Cotton Company, of Central Falls, R. I., has made a remarkable record in the way of low fuel cost which for one year amounted to $5.80 per i. h. p., the average output being about 1500 h. p. This low figure was primarily due to the use of a low grade mixture, costing only $2.29 per ton, the burning of which was rendered possible by the introduction of mechanical draught. The fan, costing less than $600, built by the B. F. Sturtevant Company, of Boston, Mass., effects an annual saving of no less than $6500 in the fuel bill.


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THE ERICSSON TELEPHONE COMPANY announces that its offices are being moved from 20 Warren Street to 296 Broadway, New York City.

THE BELKNAP MOTOR COMPANY, Portland, Me., has appointed Mr. A. W. Koenig as its representative for the middle and southern states after May 1st, 1899.

THE ONONDAGA DYNAMO COMPANY and THE S. E. I COMPANY, of Syracuse, N. Y., have placed the general agency for their goods in New York City and the territory contiguous thereto in the hands of Mr. Jay Holmes at 39 Cortlandt Street, New York City.

THE COMMERCIAL ELECTRICAL SUPPLY COMPANY, of St. Louis, Mo., has passed out of the hands of its former owners and into the control of Mr. Wm. F. Nolker, sons and associates, who hope to make the company one of the foremost supply houses of the West.

THE AMERICAN SILK MANUFACTURING COMPANY, of Philadelphia, Pa., announces that it is meeting with remarkable success with its engine and dynamo wiper, made out of pure raw silk to take the place of the ordinary cotton waste generally used for this purpose.

THE SHAWMUT FUSE WIRE COMPANY, of 93 Federal Street, Boston, Mass., was burned out of both office and factory at this location on March 27. The company has secured permanent quarters at 161 High Street, Boston, where it will be pleased to receive customers and friends.

THE WESTON ELECTRICAL INSTRUMENT COMPANY is preparing for the construction of its new factory at Waverly, N. J., a suburb of Newark. Ground will be broken in a few days for the erection of what will probably be one of the most complete manufacturing establishments in the country.

THE ELECTRICAL BUREAU OF THE NATIONAL BOARD OF FIRE UNDERWRITERS has removed its Chicago office and Laboratory to No. 67 E. Twenty-first Street, where all communications to the Western office of the bureau, or to Mr. W. H. Merrill, Jr., the electrician of the bureau, should be addressed.

THE CLAYTON & LAMBERT MANUFACTURING COMPANY, of Ypsilanti, Mich., maker of gasoline fire pots, etc., has recently contracted for a new factory adapted to its increasing needs. The new works will be located in Detroit, the structure being of brick and stone 40 x 75 feet and three stories high.

THE STANDARD UNDERGROUND CABLE COMPANY of Pittsburg, Pa., is now furnishing a 2 conductor cable 2500 ft. long for the Tennessee and Arkansas Telephone Company, to be placed under the Mississippi River at Richardsons' Landing, Tenn. The company has been using an overhead wire for a year, but it gave too much trouble.

THE CUTLER-HAMMER MANUFACTURING COMPANY, of Philadelphia, has recently certified to an increase in its capital stock from $50,000 to $100,000, the fourth increase in the six years of its existence, the original capitalization being $10,000. The increase was, as were the others, necessary for carrying on its rapidly increasing business.

THE ABILITY TO MAKE OR EVEN READ an elaborate drawing with all the conventions and refinements of modern drafting is a most valuable and rather rare attainment among electrical engineers who have not seen active drafting room service. The International Correspondence Schools of Scranton, Pa., offers short courses in mechanical drawings with complete drawing outfits, which make the acquisition of this attainment comparatively easy.

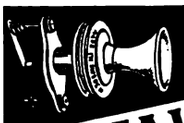
THE HARRISBURG FOUNDRY AND MACHINE WORKS have been awarded the contract for engines of a capacity of over 4000 h. p. for the immense new plant of the Great Northern Paper Company, which will be the largest paper producing plant in the world. There are ten engines in the order.


— THE —
CROSS OIL FILTER

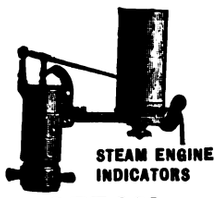


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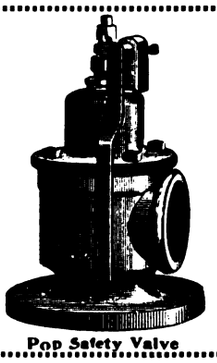


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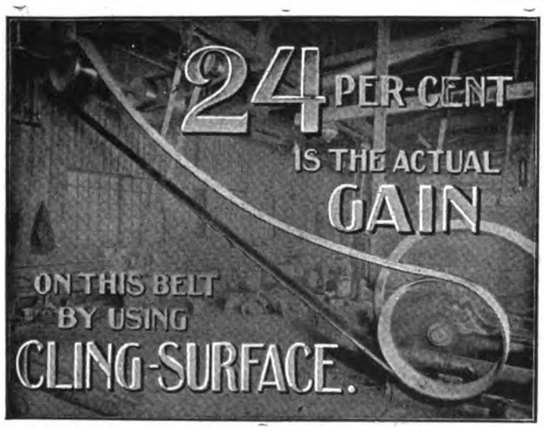
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All belts will stop slipping, that THE POWER WILL BE PERMANENTLY INCREASED, that belts can be run SLACK, that in leather belts the leather will become as SOFT as calfskin and ABSOLUTELY WATERPROOF; and furthermore that the INCREASE in power in a fair-sized plant will earn the cost of the sample can EVERY month, if used as directed. This applies to all belts, leather, rubber, cotton or a rope drive, whether they are new, old or oily. We will send you a sample can, or if you prefer we will advise you fully as to its nature.
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each engine weighing 60,000 pounds, which will develop 350 h. p., maximum capacity 400. This order is just one-half of the entire order, the aggregate of which will be nearly ten thousand horse power. This is the largest order for engines of the wheel governing type ever placed in this country.

THE ANNUAL MEETING of the stockholders of the Joseph Dixon Crucible Company was held at the company's main office, Jersey City, N. J., Monday, April 17, and out of a possible vote of 7,345 shares, there were 7,069 shares voted for the re-election of the old board, consisting of Edward F. C. Young, John A. Walker, Daniel T. Hoag, Richard Butler, William Murray, Alexander T. McGill and Joseph D. Bedle. President E. F. C. Young, Vice-President and Treasurer John A. Walker, Secretary Geo. E. Long were re-elected by the directors. Judge Joseph D. Bedle was also re-elected as counsel.

THE WARD LEONARD ELECTRIC COMPANY has put on the market the "TR" type of motor speed regulator suitable for machines from 1/16 to 1 h.p. inclusive. The resistance material in this regulator consists of wire wound around pottery tubes, which are then covered with two or more coats of specially prepared porcelain enamel, completely covering and hermetically sealing the resistance. These tubes are made up in three standard sizes, rated according to their power dissipating capacity, viz., 36 watts, 72 watts and 144 watts, continuous duty, there being 26 different graded resistances for each capacity unit.

THE MONTAUK MULTIPHASE CABLE COMPANY has recently received a large additional order from Melbourne, Australia for its fire detective cable. It is quite remarkable that an American product of such recent production has created a demand for itself at such a great distance. A noted fire department engineer has recently stated that if he could have five minutes' notice of any fire he could suppress the same in the next five minutes. The Montauk Multiphase Cable gives instant notice of dangerous heat. The company has recently opened a branch office in the Brazer Building, 27-29 State Street, Boston, Mass., at which place the various electrical adaptations of the cable are shown with sections of the dangerous parts of buildings and the way in which they may be wired for detecting fire.

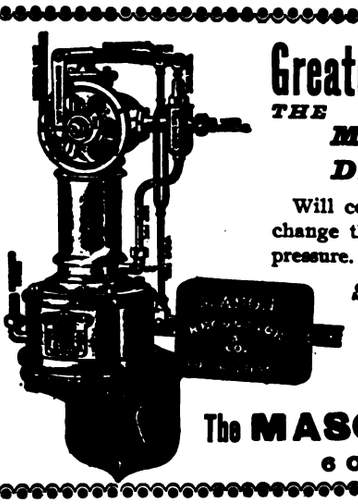
THE WATERTOWN STEAM ENGINE COMPANY announces that the New York State Hospital at Ogdensburg has just installed a new plant, including four Watertown high-speed engines. The new four-valve Watertown high speed is making a very satisfactory record for economy. Results are especially satisfactory when the engine is running (as must sometimes happen) at much less than its rated horse-power. For example: An engine whose normal load is 180 H.-P. has at times been put to do the work of only 75 H.-P., and this it has done with less steam consumption than a standard high-speed engine of good make of 80 H.-P. In other words, the four-valve Watertown engine at less than 50 per cent. of its rated load has shown better economy than the standard high-speed engine at nearly or quite its full load.


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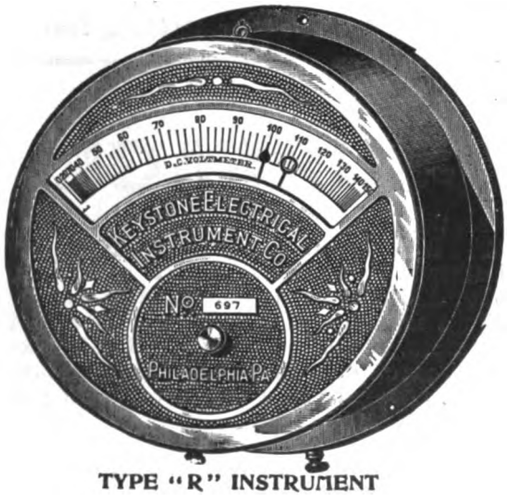
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# American Electrician.

Vol. XI | New York, June, 1899. | No. 6.

## SOME ENGLISH CENTRAL STATIONS.

### ILLUSTRATING FEATURES OF CENTRAL STATION ENGINEERING DIFFERING FROM AMERICAN PRACTICE.

The development of central stations, or as the English call them, "electricity works," has proceeded in England apace with that in America, so that unlike electric traction, which has copied and therefore closely resembles American practice. English central stations have many details and even main features quite strange to American eyes. As a rule the English stations are small as compared with the general run of central stations on this side of the water, owing perhaps to the fact that the English towns were already as a rule equiped with gas plants before electric lighting was perfected; while American towns have largely grown up since the development of electric lighting, so that the central station has often preceded the gas works.

There is this striking difference, however, between these small English central stations and those of the same size here, viz., that the English plants are invariably worked out on the plan of low depreciation and a permanent investment, with the highest class of direct coupled machinery, high grade switchboards, underground distributing systems, etc., thoroughly studied to allow for future extension and to remain in service—barring revolutionary changes in practice—for 50 to 100 years to come. Taking the average run of plants of the same size throughout the rural towns of this country and especially of the West, it will be found that they are generally equipped with wooden buildings, belted machines of various types arranged and erected in any way that came handy, skeleton switchboards, slipshod overhead pole distribution, etc. This comparison is not intended as a severe criticism of American practice, as the rapid growth of American cities makes any intelligent provision for the needs of a score of years hence impossible at the present time, so that an expensive plant would prove an unwise investment, while the comparative stability of the English population makes a predetermination of the needs of the future more accurate.

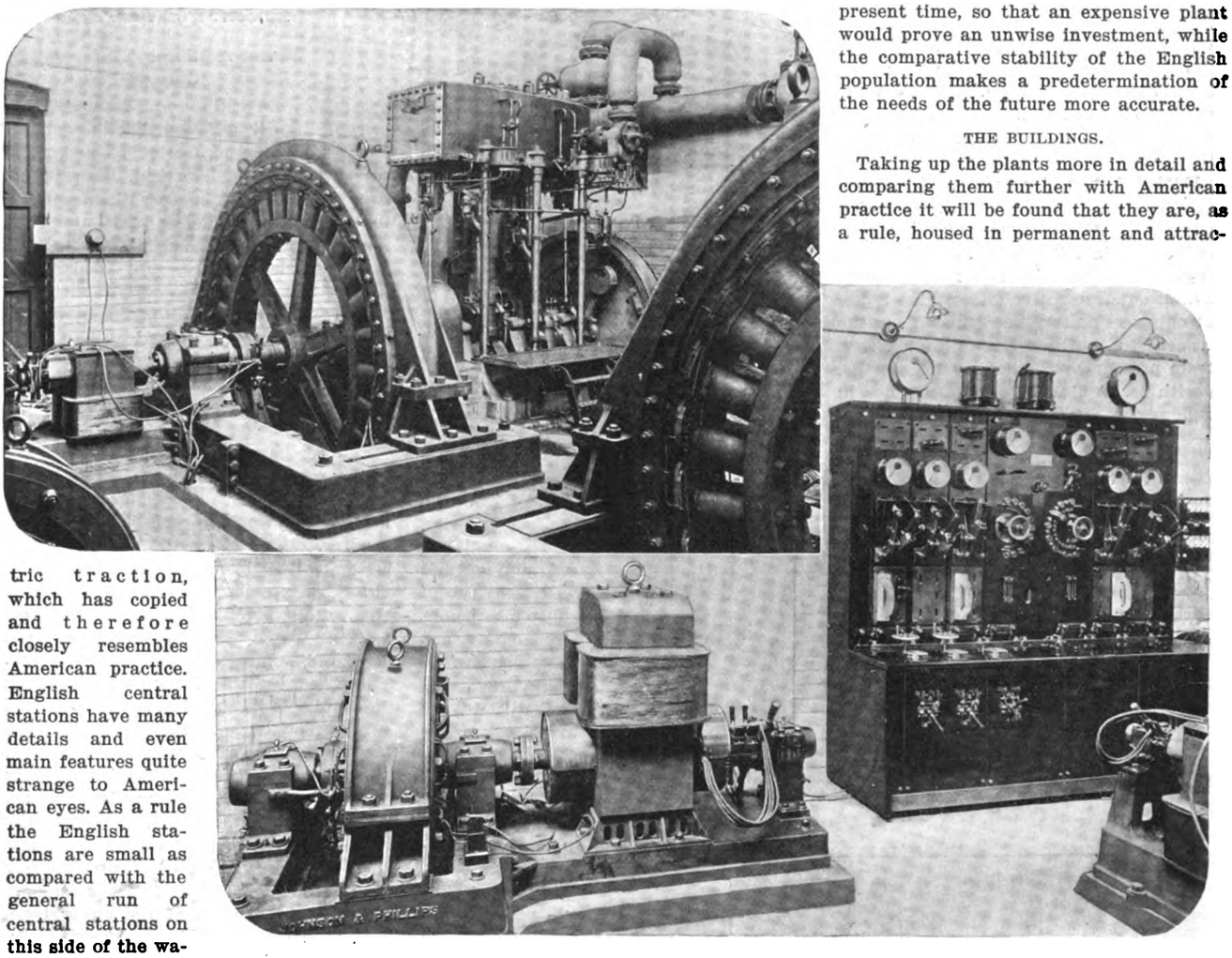


FIG. 1.—TWO VIEWS OF THE ALTERNATING CURRENT STATION AT ECCLES.

#### THE BUILDINGS.

Taking up the plants more in detail and comparing them further with American practice it will be found that they are, as a rule, housed in permanent and attractive appearing brick structures, generally designed with considerable architectural taste, resembling more than anything else municipal waterworks and similar public structures in this country. High brick stacks are customarily used, forced or induced draught being apparently almost

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unknown. The exterior of a typical structure for this purpose is shown in Fig. 1. The general lay out of the plants also resembles that now approved in this country, viz., a pair of main bays parallel with each other, one containing a row of boilers backed up against the division wall between the two bays, just the other side of which is a corresponding row of engines and generators. In the plant shown in the illustration referred to there are two such main bays, which are arranged with a row of coal bunkers in a separate structure running alongside the boiler house and a battery room adjacent to the engine room. This particular plant follows also the general custom now favored in this country of using steel truss roofs and an overhead crane spanning the engine room.

### THE BOILER EQUIPMENTS.

Coal conveying apparatus is comparatively rarely used, while on the other hand mechanical stokers are quite common. Fig. 3 shows a view of three boilers, two of which are fitted with automatic stokers, the appearance of which is strange to American eyes, as is the use of such stokers fed by hand. Although the water tube boiler is finding its way into English central stations, most of them still prefer the comparatively old and well-tried Lancashire and similar internally fired types, such as are represented in Fig. 3. Nothing resembling these boilers is found in this country, containing as they do no small fire tubes such as we have in our locomotive and marine types, but only one or two main tubes from the furnaces to the rear end of the boilers. Steam pressures vary around 150 pounds, as with us. A steam specialty common in England, but unknown here, is a special safetly valve attached to a float inside of the boiler, which opens the valve in case of low water. Such a valve is shown in the section of a Lancashire boiler—Fig. 5.

Economizers are found in England much more frequently than in this country and the general layout of the steam piping closely resembles that known here, the only difference being perhaps the more general use in England of duplicate headers, ring mains, duplicate feed piping, and the liberal use of copper bends, branches, etc. Motor driven feed pumps, etc., are gradually taking the place of direct acting steam pumps in England, as well as in this country. An ingenious arrangement of pump valves and by-passes for grouping together on one valve board the complete controlling arrangements of two pumps with either hot and cold feed or suction to either or both pumps is shown in Fig. 6.



FIG. 2.—EXTERIOR OF THE FOLKESTONE MUNICIPAL PLANT.

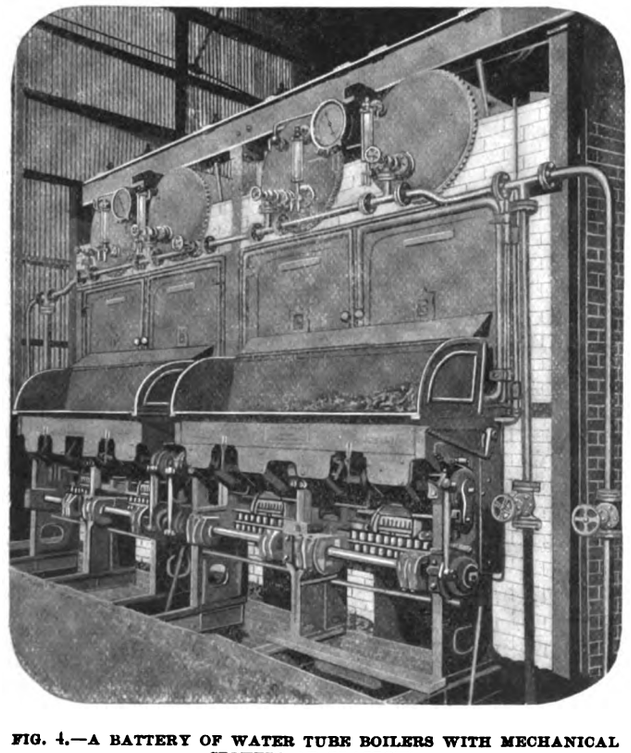


FIG. 4.—A BATTERY OF WATER TUBE BOILERS WITH MECHANICAL STOKERS AT GLASGOW.

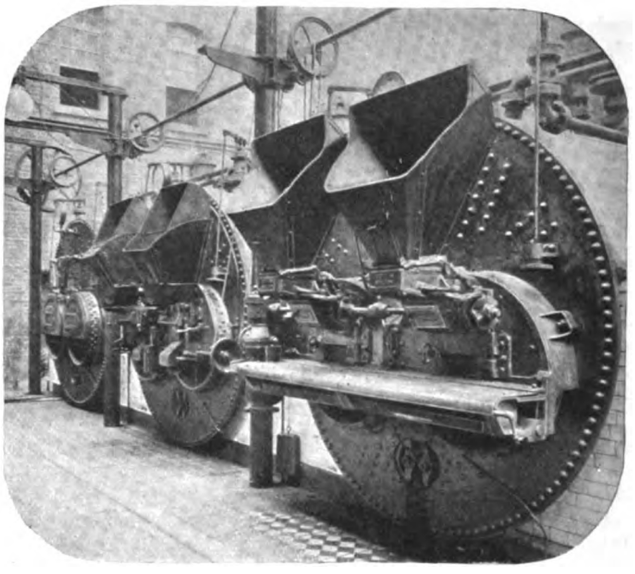


FIG. 3.—THE BOILERS OF THE BELFAST MUNICIPAL STATION.

### THE ENGINE ROOM.

Coming to the other side of the wall separating the engine room from the boiler room it will be found that the average English plant generates only one kind of current and uses vertical, high speed, two or three crank engines direct coupled to the generators. The horizontal high speed engine so often used in central stations and almost universally used in isolated plants in this country is practically unknown in England. The Willans engine is apparently the greatest favorite in English work, Fig. 9 showing an equipment of this kind, using both 2 crank and 3 crank Willans engine, each of the steeple compound type.

Another peculiarity of English practice is the continued use of the throttle governor, which has almost gone out of existence for work of this kind in this country. Very often the throttle valve is controlled by a shaft governor by means of a collar transmitting the motion to the valve, and is often fitted with a spring which can be adjusted while the engine is running, for varying the speed. The writer knows of one plant in which the voltage is regulated in this way, as well as the distribution of the load between the dynamos running in parallel with each other, the field rheostats being rarely disturbed. In direct-current plants, which preponderate in England, these engines are mounted with their crank shafts low down between two girders cast in one piece, which, extended, forms a support for bipolar dynamos of the under type, i. e., with the fields above the armature. Fig. 7 shows such an arrangement. The generator field magnets are as massive as those of the now obsolete Edison bipolar type, so widely used at one time in this country, and give good regulation, without compound windings, owing to the stiffness of the fields.

The favorite system of distribution is the 3-wire, the English patents on which have already expired, and in all new

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plants the voltage adopted is 400 to 450 volts between the outers using 200 to 220 volt lamps between each outside main and the neutral. The current is often generated by three wire sets, consisting of two of these bipolar dynamos coupled to opposite ends of the engine shaft as the lower illustration of Fig. 10 shows, but in many plants single generators, giving 450 volts, are connected straight across the outer conductors, these generators taking the main part of the load, any difference between the loads in the positive and negative sides being taken up by the balancing sets. In some plants 3 wire balancing generators are not used at all, all of the generators giving the full voltage between the positive and negative mains, the proper voltage of the neutral being maintained midway between that of the outers by means of balancing transformers consisting simply of two 225-volt machines coupled together and connected in series across the outer mains with the neutral connected between them. In case this balancing set fails for any reason, the storage battery, which is an invariable accompaniment of these plants, can be depended upon to maintain the balance, the neutral being connected in to the middle of the battery.

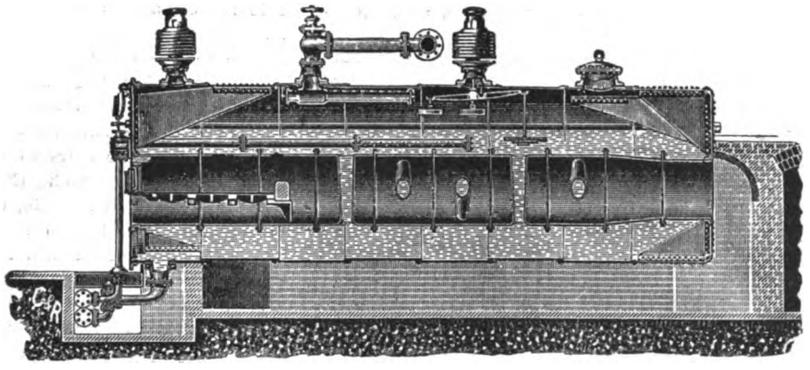


FIG. 5.—CROSS SECTION OF A TYPICAL LANCASHIRE BOILER.

Another method of direct current generation quite well known in this country is what is known as the "Oxford" system, in which the power station generates direct current at a voltage much higher than that at which it is used, and may, therefore, be situated some distance from the district supplied. A notable plant of this kind is that at Shoreditch, which has become quite famous owing to its use of refuse for fuel, the dynamos there generating direct current at 1100 volts constant potential, which is transmitted to sub stations and then transformed down by means of motor dynamos, or what have been termed in this country, dynamotors, i. e., direct-current machines with two windings and two commutators on one armature and with one set of fields. A notable feature of some machines of this kind is the use of a grounded metallic shield between the high and low-tension windings to prevent the high-pressure current from getting into the distribution system.

Fig. 8 illustrates part of a sub station of this kind where the power is transformed from the pressure of 2200 volts at which it is generated, to 450 volts, at which pressure it is distributed in a 3 wire system. A storage battery across the low-tension mains constitutes a part of the equipment of a part of this sub station. In such cases the power station is also, as a rule, equipped with low-tension dynamos to supply loads in its neighborhood, with storage batteries and motor generators to transform from the low to the high pressure or vice versa. The fields of the high-pressure machines are in that case supplied with current from the low-tension mains to avoid the use of very fine wire. Fig. 9 illustrates such a plant, the two larger machines giving 2250 volts and the two smaller machines in the background the low-tension, the motor generating set in the foreground serving as a link between the two.

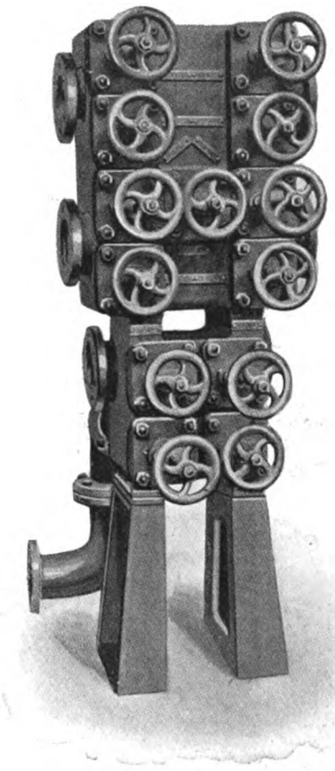


FIG. 6.—A PUMP VALVE BOARD.

Owing to the use on 3 wire systems of pressures double as high as are used in this country, the stations are enabled to supply the scattered loads of the smaller cities without recourse to alternating currents, so that alternating current plants are not as frequently found as in America.

ALTERNATING CURRENT PLANTS.

A few facts about one representative plant, however, and another that stands alone, there being nothing like it the world over, are given below.

The first is illustrated in Fig. 1, being, like many of those illustrated and described above, a municipal undertaking. The engines are cross-compound, of a vertical marine type, open front and direct coupled to revolving field fly wheel alternators, which generate 120 kw. each with a frequency of 50 cycles per second. The engine governors are of what is known in England as the "Begtrup" type, utilizing a single weight, and corresponding to the Rites inertia governor familiar here. The exciters are bipolar machines direct coupled to the ends of the alternator shafts. In this plant there is also what is known as a motor alternator, which is shown in the illustration. It consists of a bipolar direct-current machine coupled to a synchronous alternator, with a capacity of 25 kw. The direct-current end of this machine is run with a 56-cell

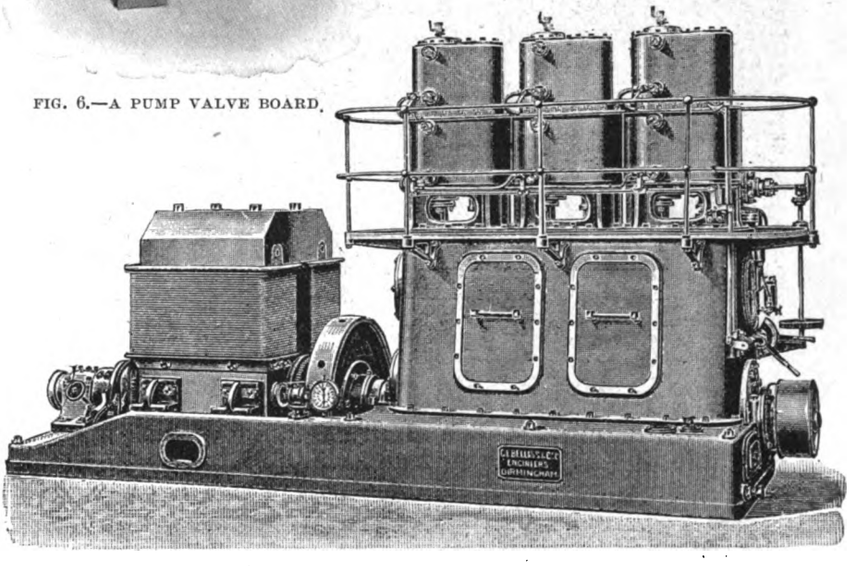


FIG. 7.—A TYPICAL GENERATING SET.

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storage battery, which it charges at convenient times, the storage battery carrying the whole alternating current load by means of the transformer action of the motor alternator, at times of light load, as after midnight. This machine also helps to smooth out the load curves of the station and to avoid running the two alternators when the load is somewhat too large for one but not sufficient to run both with a good economy. A peculiarity of this battery is the fact that its cells, which contain 55 plates each having a capacity of over 1500 ampere hours at a 2-hour discharge rate, are enclosed in lead boxes mounted on oil insulators.

The other alternating plant referred to as forming a class by itself is the world-famous Deptford installation of the London Electricity Supply Corporation, to which a new machine has recently been added which is shown in section in Fig. 11. This, like its predecessors, is a Ferranti single phase alternator of the disc type, i. e., with a thin, ironless armature revolving between the field poles. The flat, thin armature coils form a disc outside the rim of the fly wheel, to which they are bound by bolts, as the illustration shows. This machine generates 10,000 volts direct in its own coils. The windings of the coils cannot very well be insulated against this high voltage from the frames in which they are held owing to lack of space, so each individual frame is carefully insulated from the fly wheel rim by bedding the bolt deeply in an insulating substance and surrounding it by a deeply corrugated insulating sleeve, which gives a long surface distance between the coils and the fly wheel. These corrugated covers of the bolts can be seen in the upper part of the machine, the lower ones not requiring them, as the winding is simply grounded at one end to the fly wheel. For this reason only one collector ring is necessary, and that is shown at the right hand side of the machine with similar bolts fastening it to the hub. To prevent the current from jumping from the coils to the poles which approach them very closely on either side, the latter are covered with micanite caps. The wheel, which is of cast iron and split, runs at a very high speed for a fly wheel of this size, viz., 156 r. p. m., giving great centrifugal strains, which are resisted by means of 6-in. tie bolts fastening its rim to a ring shrunk on to the shaft inside the hub, there being 8 of these tie bolts spaced around the wheel between the spokes.

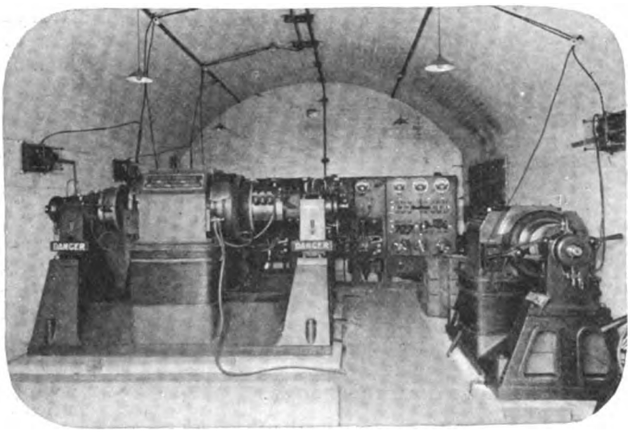


FIG. 8.—A MOTOR GENERATOR SUBSTITUTION AT HULL.

The speed gives the armature coils, which have a pitch diameter of some 20 ft., the enormous peripheral velocity of about 10,000 ft., or almost two miles per minute. There being 64 poles on each side of the armature, the frequency is about 83 cycles per second. This machine, with others of the same type in the same station, undoubtedly generates a

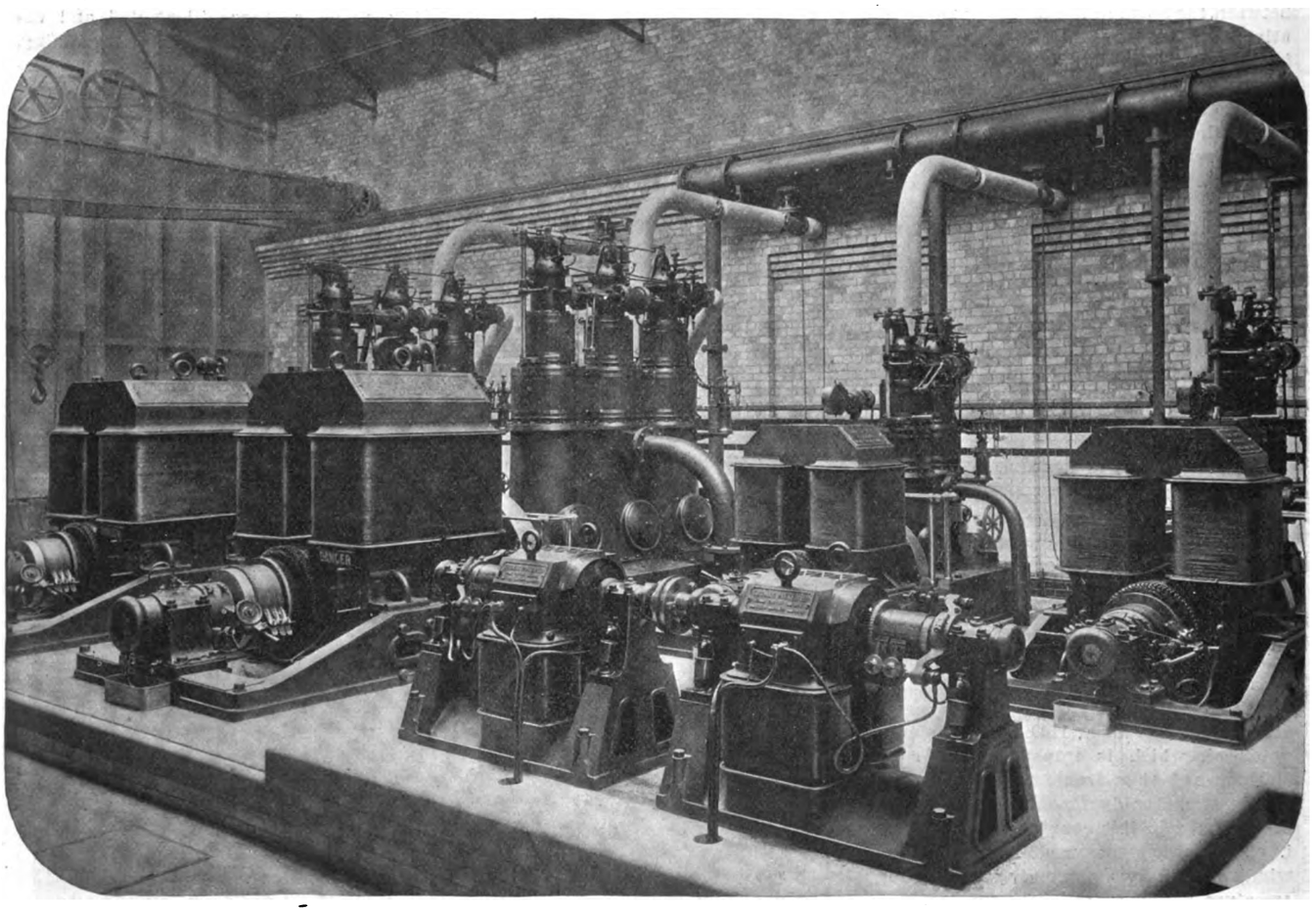


FIG. 9.—HIGH AND LOW VOLTAGE GENERATORS AND MOTOR GENERATOR OF THE HULL MUNICIPAL PLANT.

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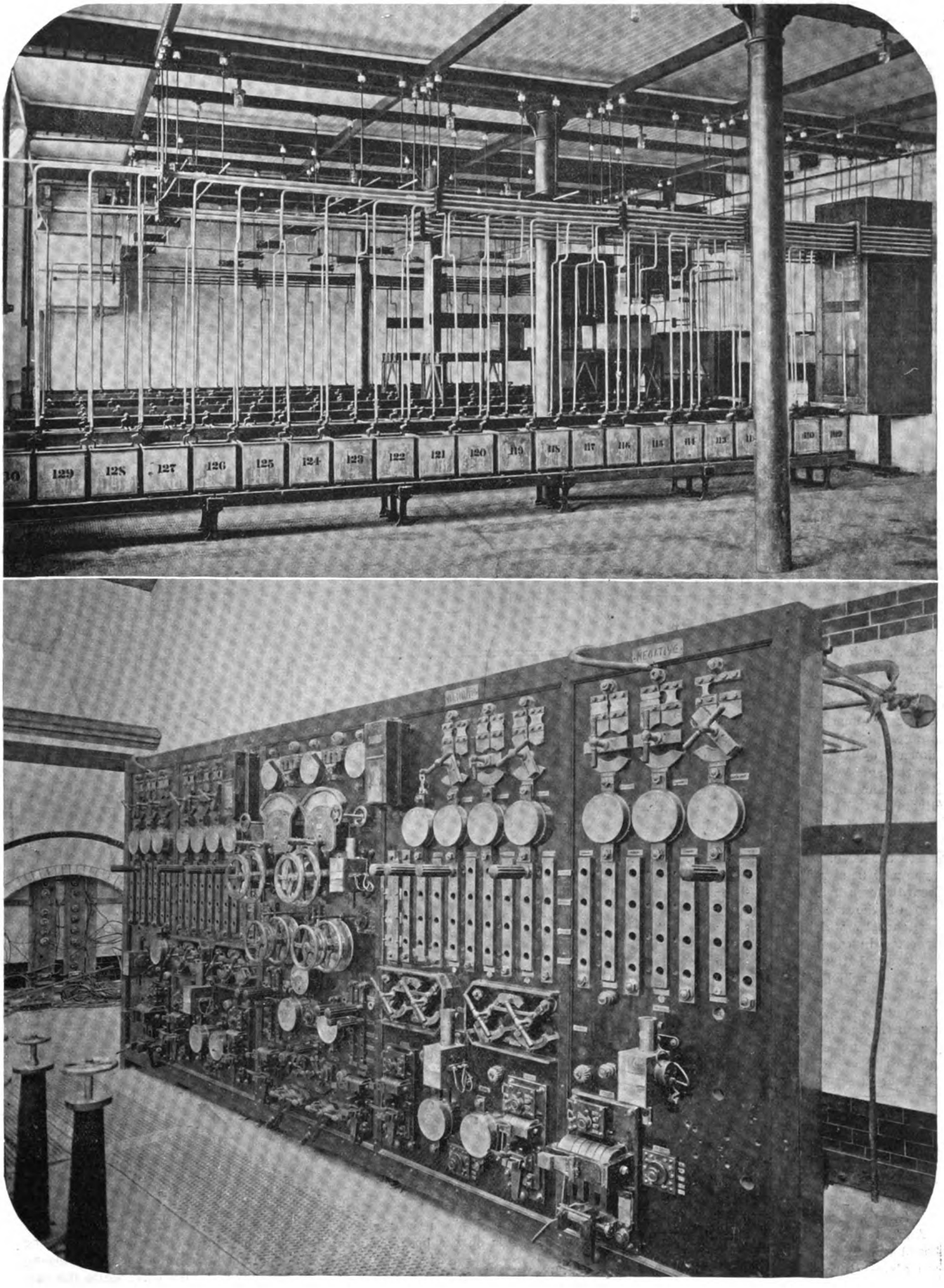



FIG. 10.—THE STORAGE BATTERY AND SWITCHBOARD OF THE MUNICIPAL CENTRAL STATION AT BELFAST.

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voltage higher than any other machine with a revolving armature, and probably enjoys, also, the distinction of having a much higher linear speed at the air gap than any other dynamo machine the world over. The engine which drives it consists of a 3-crank, 6-cylinder, steeple compound set, rated at 2200 h. p. It is governed by three ordinary fly ball throttle governors, one for each high pressure cylinder, and the steam is controlled by piston valves in the high pressure and slide valves in the low pressure cylinders, driven by single eccentrics, the whole machine being of the simplest character.

SWITCHBOARDS.

Switchboards and switchboard details differ, of course, from American practice much more than do larger machines, owing to the greater chances for many different and equally satisfactory designs of each part. Slate seems to be the accepted material for switchboard panels, marble being rarely, if ever, used. The lower half of the illustration, Fig. 10, shows a board in which the connections between the dynamos and the several bus bars are made by means of plugs similar in principle to the early types of telegraph plug boards. Across the back of the board the bus bars run horizontally, while the dynamo terminals are connected to vertical strips on the front of the board, so that by proper plugging, various combinations of circuits can be made.

English generators are, as a rule, connected through automatic circuit breakers, which are almost invariably fitted with underload release, i. e., so arranged that when the load falls off to a certain small value, such as 10 per cent. of the rated output of the machine, the breaker opens automatically. With such an arrangement all that is necessary to shut down a dynamo is to turn off the steam. As the speed falls the load falls off until the breaker opens when the dynamo delivers but little or no more current. Sometimes the breakers are also fitted with overload release and sometimes fuses are used. Circuit breakers of this type may be seen in the lower part of the board shown in Fig. 10. The fuses at the top of the same board have rotating switches by which another fuse may be inserted in case one burns out.

Storage batteries on the 3 wire system are as a rule fitted with end cells connected not between the main battery and the outer mains, but in the middle, between the two halves of the battery proper and the neutral, thus all the end cells of both sides of the system are brought together in series with each other, where they may, if desirable, be separately charged by one low voltage machine. Boosters are often used also for charging the batteries, and as a rule are driven by being simply coupled to the balancing motors described above, Fig. 13, showing such a set, consisting of two balancers and two boosters.

Another peculiarity of English switchboard work is the fact that the dynamos are almost invariably controlled at one polarity; thus in the case of the 3 wire system the connection from the machine to the neutral is left permanently in and the switches, fuses, circuit breakers, ammeters, etc., are all connected between the machines and the outer bus bars. Even in the case of alternating plants the same principle is carried out, the big Deptford machine described above being grounded at one polarity, the other polarity only being carried to the switchboard. This practice probably originated from the fact that it is quite customary in England to permanently ground 2 wire systems, which practice may be traced further to the prevailing use there of concentric feeders, the outer conductor of the feeder being the grounded one to reduce the strain on the insulation surrounding it, and in fact to practically do away with the need of any such insulation.

Another detail of switchboard work strange to American eyes is the arrangement of the panels on the board, shown in Fig. 1. Here all the six panels are hinged at the bottom in such a way that they may be swung forward to examine the connections behind them, in which position all the contacts to the panel are broken, leaving the switches and all instruments upon them dead.

DISTRIBUTING SYSTEMS.

Practically all electric wires are carried underground in England in lead-covered cables, which are not always, as in this country, drawn into conduits. Several vitrified conduit systems are in use,

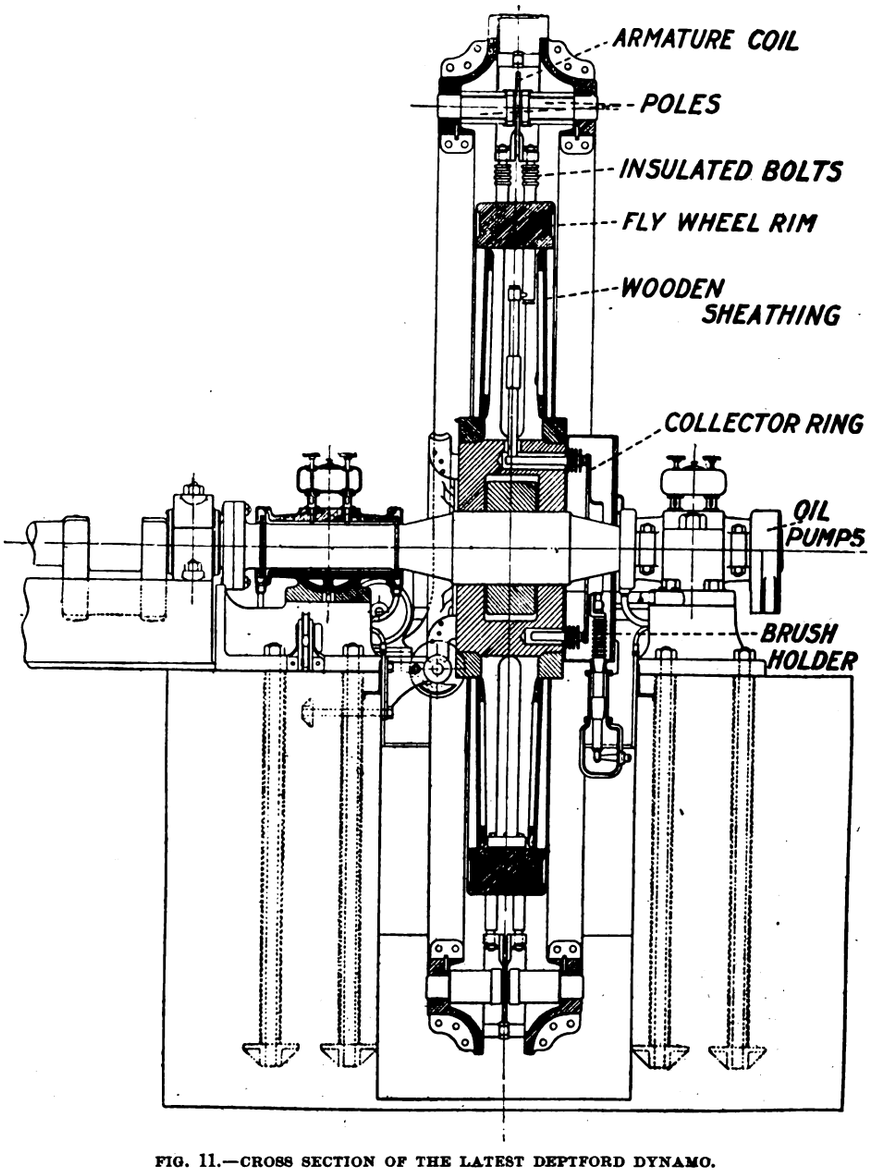



FIG. 11.—CROSS SECTION OF THE LATEST DEPTFORD DYNAMO.

but often the cables are yarned and armored by means of steel tape or wire and simply laid in a trench. Sometimes they are laid in a wooden box or trough, with pitch or bitumen run around them, while in other cases they are simply covered with boards to prevent workmen from striking them with picks. The feeders are almost universally concentric cables, in the case of three wire or three phase systems triple concentric, the outer conductor being the neutral or grounded one of the three. The central core or conductor is, as a rule, a cable made up of ordinary stranded wire, while the sur-

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rounding conductors are often made up of copper straps interlocked. These concentric cables were also used for distributing mains in the past, but the latest practice seems to favor 3-core cables, not concentric, but somewhat similar to the cables used in this country. These are lead covered and are often joined by means of cast-iron coupling boxes, filled with an insulating cement, similar to the coupling boxes used on the Edison tubes under American streets.

ARC LIGHTING.

Very few series arc machines are used in England, the majority of direct current plants running the arc lights from the constant potential mains just as is done in this country by the Edison companies, but with a greater number of arcs in series on account of the higher voltage. The plants working on the "Oxford" system described above, with constant potential direct current machines giving 1100 or 2200 volts, work arcs on multiple series 20 or 40 lamp circuits across these high voltage constant potential mains, connected up just as series incandescent circuits are in this country.

One peculiarity of English street lighting is the fact that the arc lights are rarely run after midnight, the arc light poles being fitted with incandescent lights, generally two per pole, which are switched on when the arc lights are turned off, very frequently by automatic switching devices. Alternating current plants supply their arc lights by means of rectifyers, which transform the alternating current to a direct current and automatically regulate so as to keep the current constant on a series circuit, no matter how many lamps are burning. A view of one of the most recent machines of this class is shown in Fig. 14, this being designed for a 50-light circuit supplied from sin-

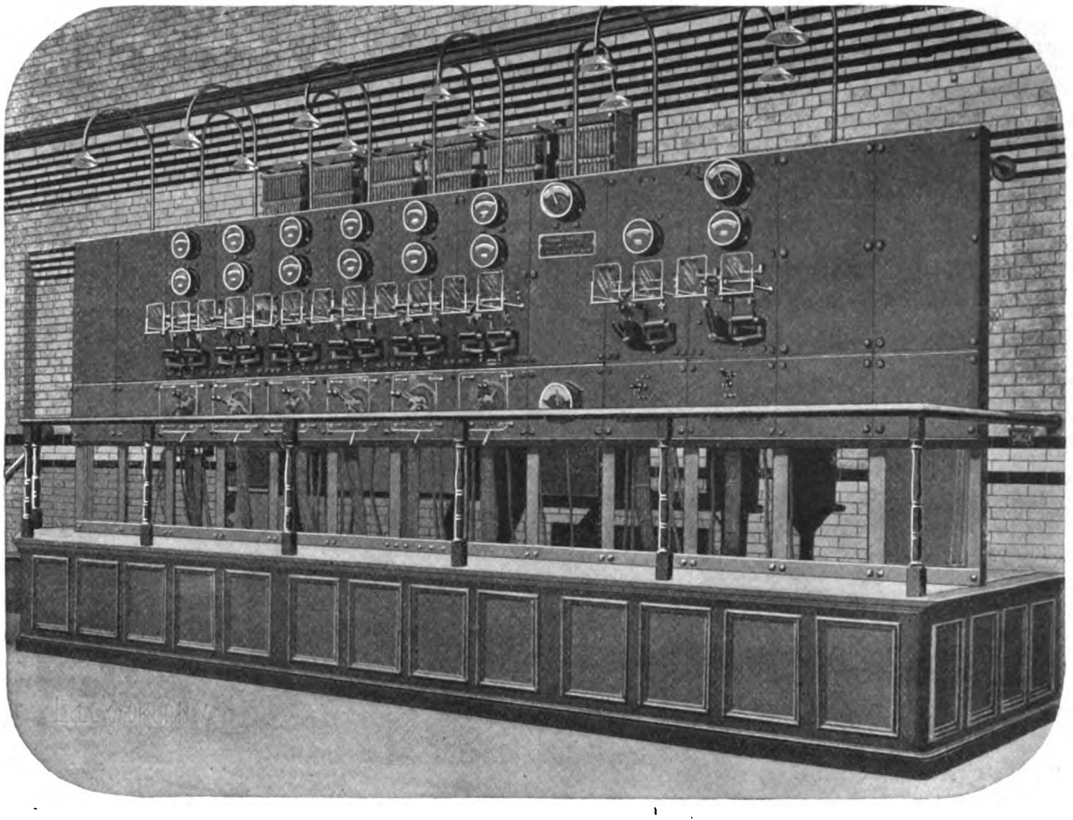


FIG. 12.—THE 2250-VOLT DIRECT CURRENT SWITCHBOARD AT HULL.

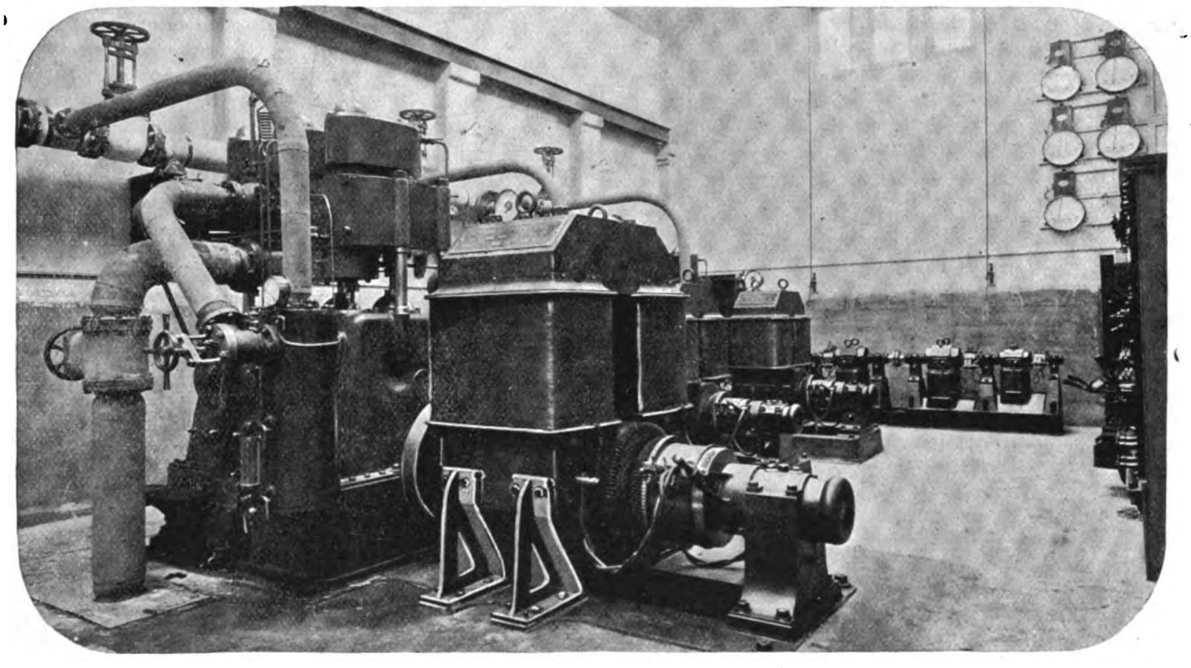


FIG. 13.—450-VOLT GENERATORS AND THE BALANCER BOOSTER SET AT FOLKESTONE.

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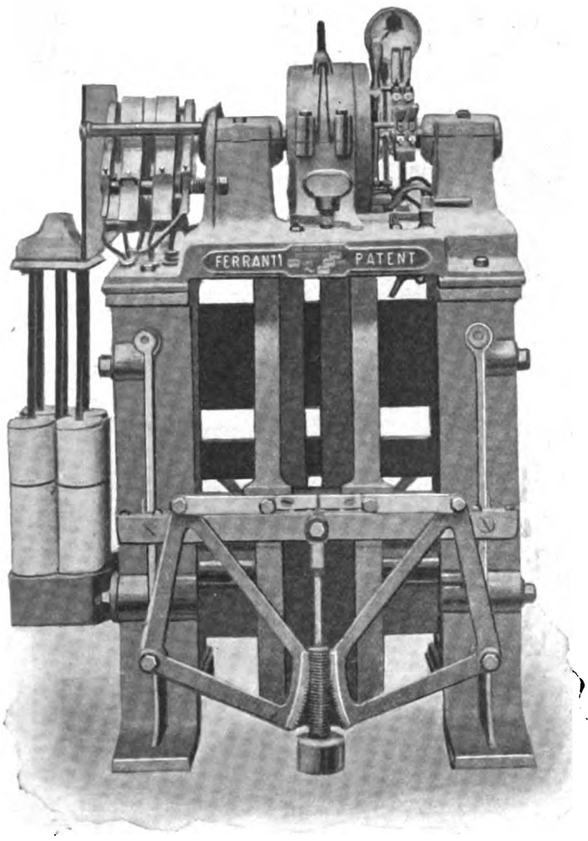



FIG. 14.—A RECTIFIER FOR ARC LIGHTING.

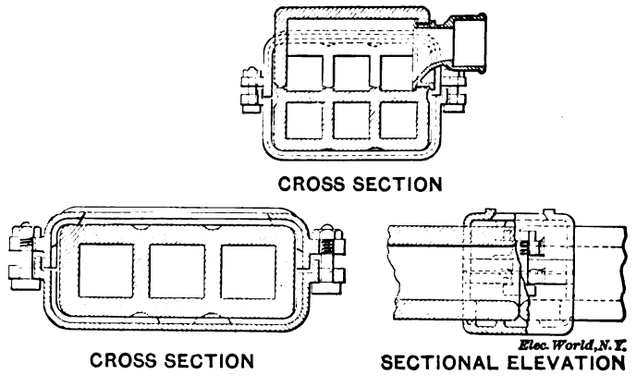



FIG. 15.—CROSS SECTION OF CONDUIT SHOWING METHOD OF JOINTING AND OF ENTERING A SERVICE.



FIG. 16.—THE IMPRESSED E.M.F. FROM A RECTIFIER.

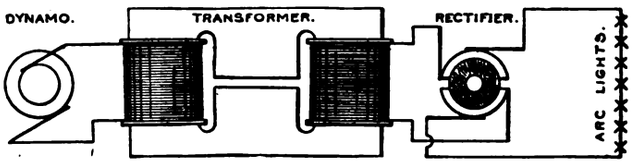



FIG. 17.—GENERAL SCHEME OF CONNECTIONS OF RECTIFIER.

gle phase currents of the usual frequency in England, viz., 50 cycles, multiphase alternators, by the way, being a great rarity in English central stations.

The general principle of the rectifier consists in the rotation of a commutator through which the arc light circuit is fed from a special transformer. By this means one-half (let us say all the negative) waves of current are reversed in the arc light circuit, which gets, therefore, a current which is unidirectional. This current, coming as it does from single phase supply, is pulsatory in character and has a wave form which may be represented roughly by the diagram, Fig. 16. The general scheme of the connections of a rectifier is clearly indicated in Fig. 17. Here the alternating current dynamo is shown feeding a transformer of peculiar shape, having considerable magnetic leakage. In such a transformer the regulation for constant potential is very poor, in fact the machine gives almost constant current. In the English machine referred to above this regulation is accomplished in another way.

The general design of the machine shown in Fig. 14 comprises a synchronous alternating current motor mounted on the top of the machine and driving the commutator, which appears at the left hand end of the shaft. Below this is the transformer, which is designed to automatically regulate in such a way as to give constant current through the rectifier to the arc lamps from the constant potential of the alternating current mains. The transformer consists, as may be seen, of two horizontal cores, one above the other, and connected at their ends by vertical yokes embedded in the frame of the machine. Surrounding these cores are the primary and secondary windings, which are free to slide horizontally, or rather to swing horizontally, being mounted on frames hung from the body of the machine. In the position shown, the primary and secondary windings are quite close to each other and are held there by means of the weight and peculiar segmental gear arrangement in the lower foreground. When, however, the load is applied, the two sets of coils repel each other and tend to push away, this push being resisted by the weight above mentioned, which tends to force them together. If the current strength becomes greater than that needed by the arc lamps the coils push apart until the magnetic leakage becomes so great that the current is reduced to the proper amount, and vice versa. When more lamps are switched in to the series circuit the current falls, reducing the repulsion, the weight pulls the two coils together, diminishing the magnetic leakage and keeping the current nearly constant. At the left hand side of the machine is shown a group of four porcelain jars filled with water and constituting, with the carbon rods, a water switch, which is used to open the arc light circuit; the high self-induction of the transformer making this opening by any ordinary switch a dangerous proceeding.

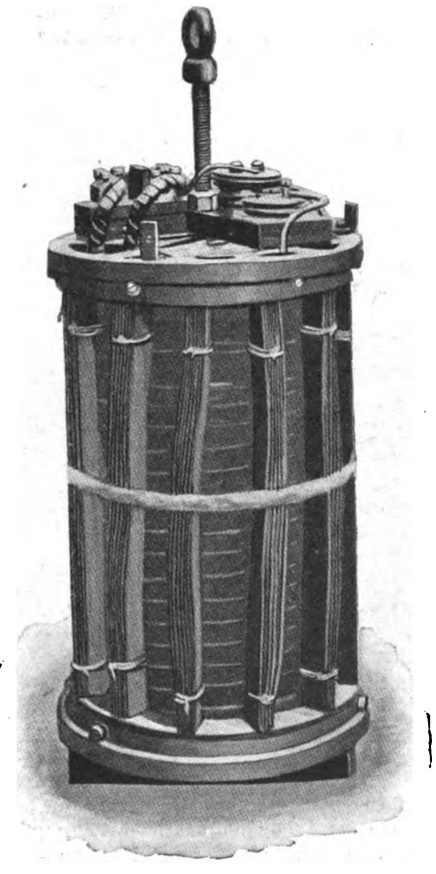


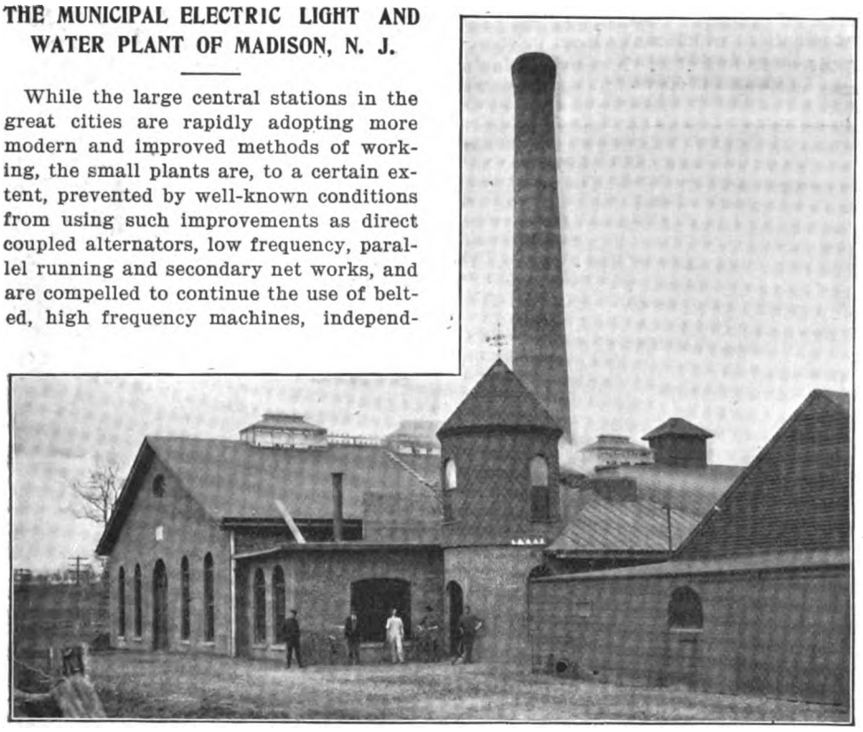
FIG. 18.—A MANHOLE TRANSFORMER.

Small house to house transformers are looked upon with disfavor in England owing to their low all day efficiency. Secondary mains, generally 3-wire, are favored, fed at intervals by large transformers. One of the latter, as designed for manhole service, is shown in Fig. 18.

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## THE MUNICIPAL ELECTRIC LIGHT AND WATER PLANT OF MADISON, N. J.

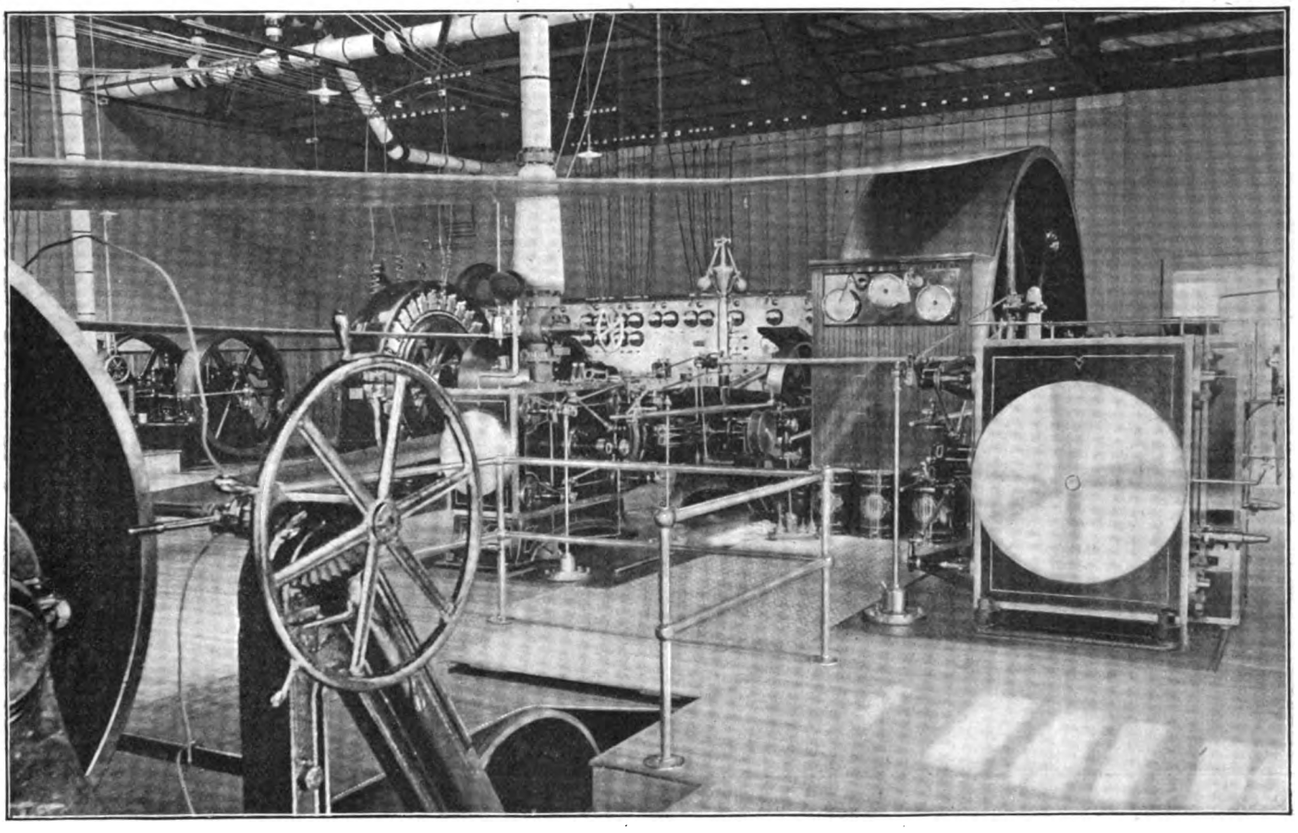
While the large central stations in the great cities are rapidly adopting more modern and improved methods of working, the small plants are, to a certain extent, prevented by well-known conditions from using such improvements as direct coupled alternators, low frequency, parallel running and secondary net works, and are compelled to continue the use of belted, high frequency machines, independently run with house to house transformers. That careful attention to details will allow such plants to depart from the general slip-shod characteristics of the old-fashioned central station and approach the trim appearance and economical working of a metropolitan plant—even when old machinery is kept in use as additions are made—is illustrated by an attractive, though small, municipal station in Madison, N. J.



THE EXTERIOR OF THE MADISON MUNICIPAL STATION.

The Borough of Madison has a population of about 4000, the heads of families being largely "commuters" from New York and Newark, and as a rule of the wealthier classes. The one little lighting plant has no competition, there being even no gas system within the city limits. It therefore carries all the residence and street lighting, the former entirely on alternating house to house transformer circuits and the latter on series alternating incandescent circuits fed by the same generators.

The plant was first built about 10 years ago and has been so successful that the load has outgrown the equipment twice since, the present outfit being the third installation. The different steps represent well the evolution of central station engineering in the last decade; the first plant consisting of a 16x16 Ball & Wood high speed engine, direct belted to a 60 kw. T. H. alternator, and supplied with steam at moderate pressure. This was outgrown in two years' time and was enlarged by the addition of a Ball & Wood cross-compound belted to a 120 kw. alternator. Condensing appeared to be desirable at that time and the consulting engineer of the plant, Mr. C. O. Mailloux—who has served the borough in the same capacity from the time it started this municipal plant until the present—decided to make use of a small stream which, however, did not have a sufficient flow for condensing purposes. For probably the first time in this country in central station work, a cooling pond was used, the cooled water being taken to the condens-



AN INTERIOR VIEW SHOWING COUNTERSHAFT TO THE LEFT, SWITCHBOARD IN THE BACKGROUND AND CORLISS ENGINE TO THE RIGHT.

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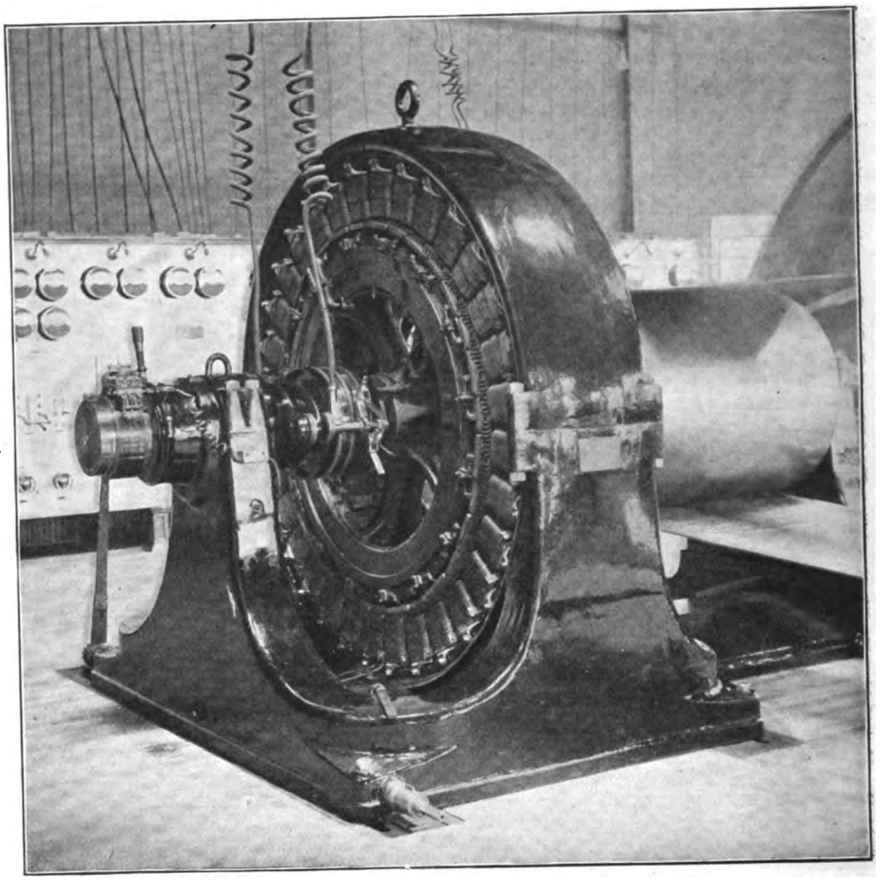
ers from one end of it and returned to the other, radiation and vaporization being depended upon to dissipate the heat given to the pond by the hot discharge of the condensers.

A few years later this plant was outgrown and the building was enlarged, new apparatus was bought and combined with the old to make the existing arrangement. The cross-compound engine was retained and belted to one end of a countershaft, to the other end of which was belted a new cross-compound Corliss engine made by Hewes & Phillips.

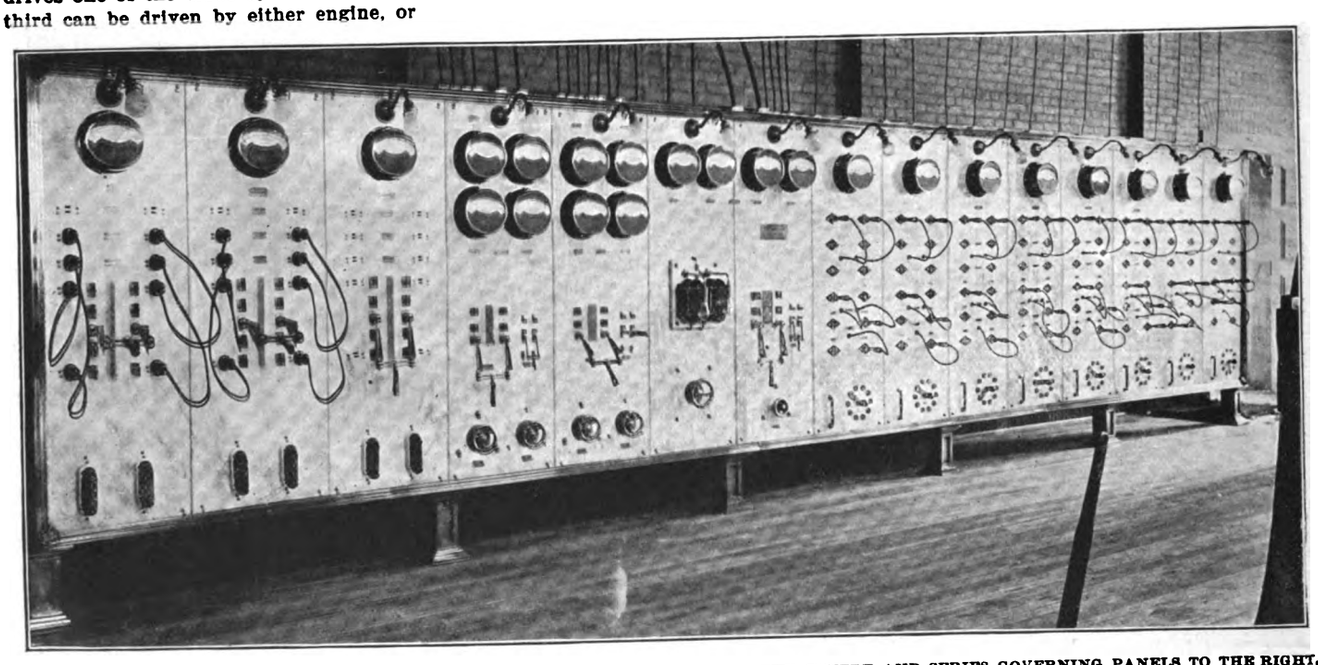
This engine has several details which particularly fit it for successful operation in a plant of this kind. The governor controls the cut-off on both the high and low-pressure cylinders, the connection from the governor to the low-pressure tripping mechanism being fitted with an attachment so that the relative percentage of cut-off in the two cylinders may be varied at any time by hand, even when the engine is running. The engine is also piped so that it may be run as two simple engines instead of one compound, increasing the capacity and doing away with the need of a larger engine to carry occasional overloads, which would reduce the efficiency at normal loads.

A new dynamo of twice the capacity of the larger one already in service was purchased and the three generators were belted to a countershaft with two friction clutches, made by the Hill Clutch Company, dividing the shaft into three sections, each end section respectively carrying the pulleys of one engine and dynamo, the middle section carrying the third dynamo, so that each engine always drives one of the three dynamos and the third can be driven by either engine, or all three sections can be coupled together and the load thereby distributed between the two engines.

The generators consist of two old T. H. alternators and one new Westinghouse machine with several improvements of recent adoption, which make it an interesting piece of apparatus. It delivers single phase current at 1100 volts with 16,000 alternations per minute and is rated at 250 kw. The armature winding is not of the unitooth or pole wound type buried in large slots, one to each pole, customary in such machines, but is distributed in a large number of slots, eight per pole. These slots are almost uniformly spaced on the surface of the armature, one tooth of each eight being, however, wider than the others. The slots are parallel sided and the armature windings are slipped into them and fastened by wooden strips in a way similar to that used on the windings of direct current machines made by



THE 250 KW. GENERATOR WITH DISTRIBUTED WINDING AND ROTATING SERIES TRANSFORMER



THE SWITCHBOARD, SHOWING FEEDER PANELS TO THE LEFT, MACHINE PANELS IN THE CENTRE AND SERIES GOVERNING PANELS TO THE RIGHT.

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the same manufacturers. The conductors are form wound into a sort of spiral or "pan cake" coil, which is slipped into the eight slots, four on each side of the central wide tooth.

Another peculiarity of this machine is the fact that the armature current itself does not pass through the rectifying commutator and series coils of the composite wound field. Rotating with the armature is a series transformer which supplies the commutator and series field with a derived current proportional to the armature current going to the collector rings. This series transformer, in order to balance the armature, is divided in two parts placed diametrically opposite to each other.

The switchboard is unusually complete, compact and flexible for a plant of this kind. It consists of 15 marble panels, four for the machines, three for feeders and eight for the series circuits and was built by Sheehan & Hewitt of Newburgh, N. Y. Each machine has four instruments consisting of the usual alternating current voltmeter and ammeter and a direct current voltmeter and ammeter for the exciter. Six bus bars are carried the length of the board, a pair for each of the three machines, and the feeder panels, which appear at the left hand end of the accompanying illustration, are fitted with double throw switches and flexible cords by which the clips of either the top or bottom of the switch may be connected to any desired one of the three pairs of bus bars. Thus the commercial feeders may be thrown from one dynamo to another without interrupting the circuit for more than a fraction of a second. If the switch is in the upper position, it is only necessary to connect the cables from the lower clips to the sockets of the desired bus bars and then throw the switch down. It is impossible to accidentally multiple the dynamos, as the plug on the end of the cable connecting to the switch clips is larger than that connecting to the bus bar.

It was aimed in the construction of the board to place all of the lightning arresters, the ground detector, the meters, station transformers, etc., which are objectionable on the face of the board, to the back of the board. For this purpose there was provided a slate slab for each one of the panels, which is held in position by suitable iron brackets and on these slate slabs are mounted the instruments and transformers named above. Thus the face of the board is kept free from those instruments, transformers, etc., which render the same unsightly.

The series circuit panels at the right hand end of the board are fitted with flexible cords and plugs by which each circuit can be connected to any one of the three machines, each panel also containing Messrs. Sheehan & Hewitt's series governing device, by means of which the current in the series circuits can be closely adjusted to the desired 5½ amperes over a wide range of resistance variations. This is acomplished by means of a transformer on the back of the panel by which the voltage delivered to the series circuit may be boosted up or down in large steps and a dial switch in the lower right hand corner of the panel, by which small inductive resistances can be cut into the circuit to compensate for the single lamps.

## ECONONY OF MULTIPLE EXPANSION ENGINES.

BY WM. S. ALDRICH.

The influence of accessories upon the economy of multi-expansion engines may be such as to entirely offset the advantages to be derived from using such a type of engine in electric power plants. Boilers, fuel economizers, feed-water heaters, have each their characteristic features and introduce variable elements in the economical working of any power plant under variable loads. Steam pumps and condensers, on the one hand, and steam jackets and re-heating receivers, on the other, introduce alike indeterminate elements under variable loads. It is impossible to do more than merely call attention to the influence of these accessories upon the economical working of the plant. It is quite improbable, however, that their varying economy under varying loads would amount to more than a small percentage of the total variation in economy of the boiler, engine and dynamo units under similar conditions.

The type and setting, methods of feeding and of firing boilers are of scarcely less importance, especially the latter. Whether hand firing or automatic stoking is adopted, the greatest care must be observed to conserve the coal pile under the varying steam supply called for by the variable demands of the electrical supply. Variations in steam quality, in storage capacity, and in efficiency are not very marked for the common types of boilers used in central stations at the present day. Whether fire or water tubular boilers are to be adapted for multi-expansion engines, the practice appears to be following closely marine precedents, as the steam pressures keep going up higher. But departures must be made to suit the new conditions and these, of course, are chiefly in the direction of larger steam spaces to adapt the boiler plant to the rapidly varying demand made upon it in electrical work, all in marked contrast to the steady loads on boilers and engines in marine service and pumping plants.

Steam jackets have not come into favor in multi-expansion engines for either electric light or railway service. From the steadier loads of the former supply it might appear that steam jackets would improve the economy, but much depends upon the skillful handling of the jackets by the engineer in charge. In railway service, the varying quantities of steam used in the cylinders cannot be accompanied by an adaptation of the steam jacket to meet these changes, producing quite variable cylinder condensation. The highly efficient jacket at one load may prove a positive loss at another load, unless so operated as to maintain such a source of heat supply for the cylinder walls as to fully make good the losses by cylinder condensation under the variable load and cutoff in any given cylinder. Altogether, the steam jacket is not an unmixed good when variable loads are considered. Its economical considerations are apparent and its reputation has been well established by more or less conclusive tests under old conditions, as in marine service and pumping plants.

Receivers for multi-expansion engines have fallen somewhat into disuse in marine service, where every effort is made to reduce weight of motive power machinery, and where it has been found that the usual piping and connections between cylinders furnish sufficient volume to prevent irregular changes in pressure from greatly influencing the economy of working. In mill engines and those for pumping plants, working as they do with very slight variations throughout the day, the practice is about equally divided, as to whether receivers shall be used or not. In electrical supply service and more especially in railway work, some provision must be made for meeting the frequent changes in volume of steam used and especially to provide that the expansion shall not be carried below the back pressure. At the same time, receivers offer every facility for re-heating the steam in its passage from one cylinder to the other. The advantages of this have been so frequently pointed out that it is only necessary here to notice this feature as one now quite essential to the economical working of steam in multi-expansion engines and especially in those of the two-cylinder type coming into extensive use directly connected to electric generators. By thus re-heating the steam, the moisture from its previous use in a high-pressure cylinder is converted into dry steam, and the whole quantity of steam may even be slightly superheated to compensate for cylinder condensation losses in the next cylinder.

The manner of working steam is of the most vital importance in determining the economy of multiple expansion engines under variable loads. As far as American practice is concerned it is primarily a question of how to obtain economic working of the steam with variable cutoffs in the use of high ratios of expansion. In general, it may be said that the conditions which insure a final release of the steam as dry steam will be conducive to economy. Therefore, if by any means we can work the steam from initial admission to final release so as always to insure the condition of final dryness of the cylinder walls at exhaust, we should secure the main point at issue in the operation of all steam power electric plants; namely, a more or less uniform economy for wide ranges of load variation. Initial superheating and the use of re-heating receivers conduce alike to bring about this result.

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The influence of the number of cylinders upon the economy of multi-expansion engines is still open to discussion; that is, whether steam shall be worked from a given initial pressure through a given range of expansions to the condensing plant in two or three cylinders, by compound or triple expansion. It is altogether a timely topic for electrical supply. The present tendency is toward reducing the number of cylinders to effect any given wide range of expansion for two principal reasons, which are especially applicable to electric power plants; namely, the structural advantages of the two-cylinder compound type over the three-cylinder triple expansion type and the remarkably uniform economy of the compound type throughout wide ranges of load variations.

The two-cylinder type in practice admits of mounting the generator between the cylinders. The three-cylinder type requires an outboard mounting of the generators on an extension of the crank shaft, usually one generator on each end, subjecting the crank shaft to enormous bending moments sometimes brought on by the sudden and great load changes. Moreover, the greater the number of cylinders the greater the complication in mechanism, the greater care needed in operation and the consequent liability to derangement or to be thrown out of service altogether.

It is quite possible to obtain by compound working the same economy as in triple working, under the same conditions of pressure and number of expansions. Moreover, the variations in number of expansions due to variable cutoff incident to the load changes, can be more economically met in a case of compound than in triple working. Added to this are the additional advantages arising from a judicious use of reheating receivers, with more or less of the so-called "drop" in pressure between the high and the low pressure cylinders to meet the variations in terminal pressures due to changes in cutoff. Two-cylinder compounds with expansion of the steam from 20 to 30 times are now built and are working with a satisfactory economy. In earlier days the high ratios of expansion would have called for three or four cylinders.

Non-condensing compound engines that are not now economical may be made to yield better results by the use of superheated steam, and to such an extent as to offset the gain that would arise from changing them to the condensing type. In other words, there may be less expense in some plants attached to superheating the steam than in the introduction of a condensing plant. The improvement, however, in evaporative surface condensers and roof condensers have recently been so marked that it would be a close question to decide.

The quality of the steam used in multi-expansion engines throughout the whole range of its working is, of course, a far more important consideration that in simple engines. It is none the less so when the uncertain elements of variable load changes are introduced. These, no doubt, produce changes in the quality of the steam, from admission to final release, which, though not now fully determined, will in time show that the economy is greatly affected thereby. Aside from the considerations of variable economy due to greater or less number of expansions incident to load changes, it is quite probable that the other and most important factor is the quality of the steam throughout the cycle of its expansive working.

Superheated steam will bring about great improvement in any case. For each type of multi-expansion engine operating under a given set of conditions, or within certain limitations as to loads, it will be found that superheated steam will insure more uniform economy when carried to the extent best suited to the given set of conditions. In other words, practical experience and a few engine trials with various degrees of superheating will furnish such coefficient of superheat as will be applicable to new installations. While a slight degree of superheat is to be obtained by throttling, or the use of pressure-reducing valves, or by the American type of construction of water tubular boilers, it is not at all sufficient to realize from this source alone the full improvement in economy under variable loads, that is possible in multi-expansion engines. The higher the ratio of expansion the greater is the improvement in economy arising from this feature alone, as well as from the additional economy due to using superheated steam.

The degree of superheat best adapted to any engine cannot be fully predetermined, as the evil effects which it is expected to counteract in part cannot themselves be fully predetermined. This is entirely apart from any thermodynamic consideration of the improved economy due to superheating as such, and relates more to the making up of losses due to cylinder condensation. These latter losses have been found to vary with the cutoff of the ratio of expansion, and the kind of surface exposed to the steam by the cylinder walls. In any given engine these elements are very nearly constant, so that the best degree of superheat to compensate for these losses may be determined at once upon the installation being turned over for service.

It is not possible to separate this question entirely from that of the influence of type of engine upon economy. More especially, since the type of engine is largely determined by the way in which the steam is worked in multiple expansion; that is, whether with or without intermediate receivers between the cylinders, intermittent, or with continuous expansion. The non-receiver type of multi-expansion engine has certain meritorious features for driving electric generators, whether it is constructed in the form of a tandem or cross compound unit. In either case it is an adaptation of the so-called "Woolf" compound engine, in which the expansion line of the low-pressure cylinder follows very closely or may even coincide with the exhaust line of the high-pressure cylinder. In this way of working steam it has been found that remarkably uniform economy may be obtained throughout wide ranges of load variations without great structural complications, on the one hand, or the undesirable feature of negative power, due to looped indicator cards, on the other hand.

The high-pressure cylinder works against a variable back pressure, according to the cutoff, to suit the load changes; the low-pressure cylinder has, therefore, a variable initial pressure, as in the case of an engine controlled by a throttling governor. The lighter the load the earlier the cutoff in the high-pressure cylinder and the lower the initial pressure in the low-pressure cylinder. This type of compound engine has been made successful. Controlled either by throttling governor or by automatic cutoff regulation, it is a type of multi-expansion unit admirably adapted to isolated plants with high-speed direct-connected generators.

The plant economy as determined by the pounds of steam per kilowatt-hour, is the controlling factor in the final analysis of this question. The most economical multi-expansion engines may be very uneconomically operated, accompanied with like negligence in other portions of the installation. The highest attainable efficiency in the individual units that make up the installation of an electric power plant is no guarantee that the best economy of operation will be secured. Certain of these units will have a desirable range of economic working which may not exactly coincide with similar ranges for other units. Certain efficiencies will reach toward a maximum, while the efficiencies of another portion of the installation will be far from a maximum. Whatever the efficiencies of the individual units, it will still be found, in many instances, that the final result of operating all of them in combination under variable loads will be to give a maximum economic range at some proportional part of the full load of the plant, which point it would be scarcely possible to predetermine without working through all of the steps in the several transformations of energy.

However, a multi-expansion engine with quite a uniform rate of water consumption for a given range of load changes, directly coupled to a generator having a high maintained efficiency from about one-third load to its safe maximum overload, will in general produce the most satisfactory results when examined from the standpoint of economy of installation and operation. The pounds of water per kilowatt-hour in large generating units of this type may be kept within a range of ten per cent. variation over a range load from one-third to maximum output. Moreover, the operating expenses become more nearly uniform and quite irrespective of transient load variations in generating units of about 1000 kilowatts and over.

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# THE CANDLE POWER OF ARC AND INCANDESCENT LAMPS.

## THE APPROPRIATE LIGHT UNIT.

BY PROF. WILBUR M. STINE.

The action of the American Institute of Electrical Engineers and of the National Electric Light Association in giving official indorsement to the opinion of scientists who have carefully investigated the subject, legalizing the amyl acetate lamp as the standard of illuminating power, renders all forms of candles obsolete for light standards. Relinquishing the candle as the concrete light standard, should the term candle-power be given up or retained?

For illustration, suppose the meter were the legalized standard of length, and that this action was generally accepted and measurements were made with meter-sticks instead of foot-rules, would it be advisable to employ the ratio of the meter to the foot, and having made the measurements with the meter unit, to express the measured dimensions in feet?

Much the same dilemma presents itself to photometrists. Scientifically and legally, candles are no longer in repute and the amyl acetate standard is the new unit of light strength. Shall a ratio between the amyl acetate lamp and the candle be employed and all determinations of the light strength of illuminating sources made against the amyl acetate standard be finally expressed in candle power terms? The first step towards an intelligent decision is the consideration of the ratio between the light strengths of the amyl acetate lamp and the candle.

It has been insisted upon that experimental evidence has shown that the light strength of the candle is a widely varying and uncertain quantity. Abandoned for this reason, it is vain to seek for a definite ratio between the amyl acetate lamp and the candle, or between any constant standard of light and the candle. The numerous candle-power ratings in the literature of photometry are only mean values obtained between wide extremes, or merely figures, and represent no physical quantity. Violle, a French physicist, states the ratio as low as,

$$\frac{\text{English Candle}}{\text{Amyl Acetate Lamp}} = 1.02.$$

The German Physical Institute places it at 1.14, and other investigators as high as 1.22.

The term candle-power being meaningless as a quantitative expression, and the amyl acetate lamp being fairly precise as a standard light, we, in this country, might follow the example of foreign photometrists and express illuminating power in terms of Hefner Units (Hefner Licht, is the current term in Germany). It might be especially desirable that the manufacturers of incandescent lamps should begin the innovation by marking their lamps in Hefner units instead of candle-power. An inconsiderable increase in illuminating power, and probably the majority of lamps would need none, would change the present candle-power ratings to conform to the new scale of:

| | | | |
|---|---|---|---|
| 10 | candle-power..... | 12 | Hefner units. |
| 16 | " ..... | 20 | " |
| 20 | " ..... | 25 | " |
| 25 | " ..... | 30 | " |
| 32 | " ..... | 40 | " |

A reasonable objection to such an innovation in lamp ratings is that the change once made, a better light standard than the amyl acetate lamp might be introduced, and the necessity would arise for a second revision of lamp ratings, and so on without an end. Referring again to the analogy between this subject and the meter as a standard of length, it may be advanced that the meter is a purely arbitrary standard of length, though it was designed to be an absolute one, and for similar reasons the candle-power may be retained as an arbitrary light unit both in name and assigned value. The analogy is only apparent, for there can exist no material representation of the candle-power unit of light, because it is an indeterminate quantity. Candle-power is then a mere name corresponding to no physical quantity, and in the adoption of the Hefner unit along with the material amyl acetate standard there is in reality nothing to relinquish but a mere custom. According to an established scientific custom there is no inconsistency in naming the unit of light after an individual connected with its development. The custom itself, though now seemingly general and firmly established, is perhaps a questionable one. In the old mythology every aspect of nature was personified and named, and though the application has changed, the principle still survives in scientific practice.

The more rational procedure would be that followed in reference to heat. A quantity of heat is expressed in terms of Heat Units or British Thermal Units. This is thoroughly scientific, entirely satisfactory and produces no confusion whatever. There are certain interested parties now at work, however, who are anxious to impose the name of an individual upon the heat unit, but as the change is unnecessary it is to be hoped that engineers and physicists will be conservative and adhere to the prevailing practice and continue the use of the term Heat Unit.

Let us apply the same reflections to the discussion in hand. Abandoning candle-power units and such descriptive and personified terms, let the illuminating power of all sources of illumination be expressed in Light Units simply. This is entirely expressive and can lead to no confusion whatever. The value of the light unit applied to the candle, Methven screen and such indeterminate light sources, can not be expressed because of variations in the light strength. But applied to the amyl acetate lamp it is a quantity whose value can be stated within very narrow limits of uncertainty. As the science of light standards advances and the light strength of the actual standard becomes expressible with very great precision, the term Light Unit will still apply with equal force. If the value of the Light Unit is changed by consent of a congress or other body, it will cause no more confusion than was occasioned by the change in the value of the Heat Unit by a redetermination of the mechanical equivalent of heat.

The unit for expressing the quantity of a phenomenon must be of the same character is the thing measured, and this unit value can be no more precise than the value of the thing measured. As the measurement of the phenomenon grows more and more precise, to the same extent will the value of the unit become more definite.

Adhering still to the descriptive designation of the light unit, it has been proposed to call it the "Photon." This would be a perfectly general descriptive term applying equally to all standards. Should the term Hefner unit prove objectionable, and a descriptive unit, based on the amyl acetate lamp, be desired, following the analogy of ammeter, the name "Amate" could be coined. But applying the criterion just established, both the terms photon and amate are objectionable, it being unnecessary to employ for such purposes an intellectual cipher code.

The Incandescent Platinum Standard.—Violle endeavored to realize an absolute, or simple and reproducible standard of light by employing a definite light giving area of an incandescent metal. He finally selected platinum as best adapted for the purpose. In order that the temperature of incandescence which he used should be reproducible with accuracy, he selected the temperature of solidification of the metal. When a metal has been fused and begins to solidify, its temperature remains constant until the change of state has been accomplished. Though the same thing is true for the act of fusion of a metal, there are reasons of which discussion would prove tedious here, why the temperature at which fusion occurs is not always the same, but varies with the past history of the metal. Platinum, in common with iron, for example, when solidifying, recalesces, or the light emitted suddenly flashes into greater brilliance, for a very short time. Violle, taking advantage of this, selected the moment of recalescence or flashing during solidification for the determination of the light strength. The mass of platinum, about one kilogramme, was melted by a compound blowpipe in a lime crucible. After the fusion of the platinum the crucible was placed immediately under a water-cooled screen, pierced with a circular hole of the area of one square centimeter. During the flashing period the surface of the incandescent platinum was found to emit a light strength nearly 19 times as great as that of the amyl acetate lamp for the square centimeter. This standard was legally adopted, though largely hypothetical, by the Paris Electrical Congress of 1881. Subsequent experiments have not confirmed the utility of this source of light and the attempt to realize a precise standard of light from

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incandescent platinum has been practically abandoned.

To recapitulate.—The leading standards of illuminating power proposed and actually used are candles, the Methven screen, the pentane and amyl acetate lamps, and the carbon arc and incandescent platinum standards.

## LIGHTNING AND LIGHTNING ARRESTERS.

BY HENRY E. RAYMOND.

The records of discharges with the apparatus described by the writer in the last number of the American Electrician dnring a number of storms have furnished very instructive and valuable data, but I will give only a few in the accompanying table.

RECORD OF LIGHTNING ARRESTER DISCHARGES, JUNE, 1898.

| Number of Times the Arresters Discharged. | | | | Coincident Lightning Discharge. | Remarks. |
|---|---|---|---|---|---|
| A | B | C | D | | |
| .. | .. | 3 | Not connected. | About 1 mile off. | Fairly sharp. |
| .. | .. | 2 | | " " " | " " |
| .. | .. | 3 | | " " " | " " |
| .. | .. | 1 | | " " " | " " |
| .. | 1 | 4 | | " " " | More " |
| .. | 2 | 1 | | " " " | " " |
| .. | .. | .. | | " 2 miles " | Faint " |
| .. | .. | .. | | " " " | " " |
| 1 | 1 | 3 | | " 200 yards " | Very severe and close. |
| .. | 2 | 1 | | " " " | " " |
| .. | .. | .. | | " ½ mile " | Less severe and farther. |
| .. | .. | 1 | | " " " | Fairly sharp. |
| .. | 1 | 1 | | " 500 yards " | Quite " |
| 1 | 1 | 1 | | " " " | Very " |
| .. | .. | .. | | " 1 mile " | Fairly " |
| .. | 1 | .. | | " " " | Less " |
| .. | .. | .. | | " 2 miles " | Faint " |
| .. | .. | 1 | | " 1000 yards " | Fairly sharp. |
| .. | 1 | .. | | " " " | " " |
| .. | 1 | 2 | 10 | 10 in 6 minutes | Lightning at varying distances and severity. |
| 1 | 2 | 8 | 36 | 38 " 30 " | |
| .. | 5 | 3 | 17 | 17 " 20 " | |
| 2 | 4 | 5 | 9 | 9 " 12 " | |

NOTE.—Discharges of more than one for each "flash" consisted of one for each main discharge, followed by smaller ones. The secondary ones were probably due to the recharging of the air drained by the first discharge.

These records show distinctly that to the comparatively low frequency of lightning discharges and probable low voltage or tension induced, a resistance introduces a smaller factor of opposition than an increased gap does, there being certain definite relations.

If now we note the forms of gaps shown in Figs. 7 to 9, we would say that Fig. 9 would discharge static more readily than

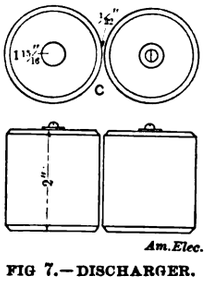



FIG 7.—DISCHARGER.

Fig. 7 would, and that the proportion of readiness would go in order through Figs. 9 to 7. Purely static probably would escape more readliy from Fig. 9 than from Fig. 7, but the disruption discharge from either jars or line shows a preference to Fig. 7. This is presumably due to the capacity of the cylinders. In fact, in testing the tanks before alluded to, I found that the path was best when it contained a gap than when the tanks were directly to ground. The gaps must be between dischargers with considerable mass.

There is one more experiment to complete the present list, and it is shown in Fig. 10. This was to see what relation resistance had to gap when used on "line arresers." It was found that up to certain limits it does not affect the discharge materially, but that when over 5000 ohms, for this size and length, a certain reactance is noticeable. This may be due as much as anything to the segregated condition of conducting particles in the graphite mixture. This figure shows an arrangement with six arrests on a 2500-volt system with two circuits. The wires are all on the same poles, and the arresters are arranged so as to give no favor to any one. The carbon resistances are all alike in size, being 6 ins. x ¾ in. in diameter, and the gaps vary slightly in length. In A the resistance is 5000 ohms, the total gap

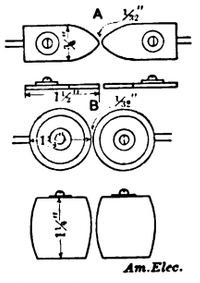



FIG. 8 AND 9.—DISCHARGER.

.052 ins.; in B the resistance is 80 ohms, the total gap .070 ins.; in C the resistance is 1200 ohms, the total gap .059 ins.; in D the resistance is 300 ohms, the total gap .057 ins.; in E the resistance is 600 ohms, the total gap .067 ins.; in F the resistance is 150 ohms, the total gap .067 ins.

An average taken from the records of several storms shows a ratio of discharge about as follows: A, 17 times; B, 9 times; C, 12 times; D, 14 times; E, 10 times, and F, 11 times. It will be noticed that the difference in the number of discharges is more in proportion to the difference in gap distance than in resistance.

Again, a question naturally arises, why should there be this dissimilarity of action between these arresters and the ones under Leyden jar tests? To best answer this, let us go over some of the most vital points.

In the Leyden jar experiments the results tended to show the following: First, that the lower the voltage the smaller the effect resistance has upon the discharge. Second, the greater the capacity, the less the discharge is affected by resistance. Third, that the shorter the resistance for given cross section, the less its influence. Fourth, that this discharge will be affected by any reactance to quite an extent.

In the action of arresters on the line, we note, first, that the discharge is opposed by considerable length of resistance, and but little by amount of resistance in ohms in shorter lengths. Second, that the length of gap determines the striking point of the arrester. Third, that the inductance of the line introduces a favorable factor. Fourth,

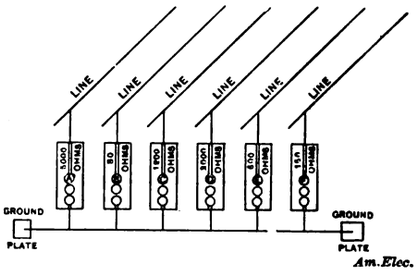



FIG. 10.—ARRESTERS ON 2500-VOLT, THREE PHASE SYSTEM.

that the capacity of the discharges affects the striking point in that for a given distance the greater the capacity, the lower the striking tension. Fifth, that reactance coils offer but little impedance to lightning discharges, and a considerable opposition to the Leyden jar sparks. Sixth, that the voltage of line discharge is much less than that of the Leyden jar, with a long gap in series with its circuit.

Let us now consider the line as a condenser alternately charged by the atmospheric disturbances and discharging to earth at certain conditions of electrostatic unbalancing, or dielectric strain. We have these differences between this condenser and its action, and the Leyden condensers and their action: The line is presumably of higher capacity, and certainly of greater self-induction. The lightning discharges are evidently of much the lowest frequency, as is indicated by the slight effect a reactance coil has upon them. It is easy to see how these few points explain the difference in action, and how they explain the fact that an arrester with a short gap and a moderate resistance in series will take a line discharge in preference to one without resistance, and with a longer gap.

There is one further condition, the presence of which we may guess from the bearing it would have upon the operation of arresters, and which we can reasonably and logically substantiate theoretically. The laboratory tests brought to light the fact that the lower the voltage of discharge with a fixed capacity, the less it would be deflected by a resistance. We have in the line certain fixed conditions and certain variable ones.

The variable ones are the capacity and the inductance, both of which are dependant on the area of country or length of line which is affected by the "storm." The fixed conditions are low frequency of discharge oscillations, and a certain gap to ground. The self-induction is always greater than in the Leyden jar arrangements, and the capacity generally is greater. With certain capacity a given charge will induce a certain potential, the tension being inversely proportional to the capacity. This tension will be further re-

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duced by the inductance in series, and the fixed gap will prevent a rise in pressure over a certain point.

The resistance is like the spring in a relief valve. An arrester without resistance may be likened to a relief valve which depended upon its own weight-mass to keep it closed, and it is obvious that the former would possess by far the least inertia. A lightning discharge has been likened to a bullet. It seems to have a similar impetus, and similar lack of momentum as of mass. It should be remembered that lightning discharges have to pass back and forth along the retarding influence of inductance, and our bullet, to make the simile fair, should pass through some medium like water, or be retarded by an elastic cord. Under such conditions as these, it is evident that an arrester or target offering the least inertia or its equivalent will be the first to give way. It is needless to add that enough resistance must prevent the passage of any quantity of dynamo current.

I want to reply to some objections which have been made to a very convenient method of rating arresters. It has been stated that it is incorrect to say that an arrester is set or designed to discharge at 2000 volts or 3000 or 5000, as the case may be. If we were going to use arresters for the protection of circuits under the influence of Holtz machines, Leyden jars, etc., it possibly would be incorrect. If our arresters are to divert only natural discharges it is perfectly correct to state that they will break down at a certain potential, because, if we take a number, which jump at various transformer potentials, and place them on the line, we will find a ratio of discharge very closely allied to the ratio of potential breakdown. No one imagines that the machine voltage is going to rise to the amount, and this ratio of breakdown under commercial voltages gives a very convenient way of referring to relative gaps. We test all machinery by the high potential test, not because we think that the voltage is going to rise to such a degree, but because it gives us comparative ratings of dielectric strength. The same idea is readily applicable to lightning arresters.

## LIMITED ELECTRIC STATIONS.

BY ALTON D. ADAMS.

A central station of low first cost and high operative efficiency to serve a limited area is a common problem in electrical design. Hundreds and thousands of small cities and towns have nearly their entire business interests within a radius of one-half mile from a central point, and the possible demand for electric light and power is such as to warrant only a very moderate outlay. When the fact that very many small central stations, in places similar to the above, run at a loss is held in mind, the necessity for careful selection of equipment is evident, and the designing engineer must decide a variety of questions with no little skill to insure a financially successful plant.

The station under consideration would be required to operate from eighteen to twenty-four hours per day, and this fact has an important bearing on the average efficiency of electrical equipment, when it is considered that the maximum load of lamps on a central station usually continues but two or three hours per day, and the load during the remainder of each day is but a small part of the maximum amount, since the variation of losses inside and out of the station does not necessarily rise and fall in the same ratio as the load.

There are two main classes of electric generators, either of which may be used to operate incandescent lamps, namely, those generators intended to connect directly with the lamps, through the proper conductors, and those intended to connect with transformers, but having no electrical connection with the lamps. Generators connected directly with the lamps are limited in electric pressure or volts to the voltage of the lamps, plus the small loss of pressure allowed in the connecting wires. Generators for connection to transformers are of the alternating current type, and may be of any desired voltage, as the proper voltage for lamps is supplied by a suitable transformer.

Alternating current generators with transformers have been much more frequently selected for stations like the above than have the type of generators suitable for direct connection to the lamps, for two reasons: First, because the weight of conductors to supply a given number of lamps at a fixed distance and per cent. of loss varies universely as the square of the volts or electric pressure at which the energy is supplied; and secondly, because until several years ago the highest practical electric pressure at which lamps could regularly be had was about 110 volts. At 110 volts the weight and cost of conductors is very large compared with other parts of the equipment, even on distances so short as one-half mile; while a voltage may readily be selected for alternating current generators, as 1000 or 2000 volts, which will reduce the weight and cost of conductors to a very low figure.

The great saving in conductors made possible by the transformer system at 1000 volts as compared with the 110 volt system is shown by the ratio, $(110)^2 \div (1000)^2 = 0.0121$ in weights of conductors for the 1000-volt system, compared with weights for the 110-volt system.

A third method of distribution, known as the three-wire system, by which the station voltage could be increased to from 220 to 250 volts, with 110-volt lamps, has also been possible, but being patented, its use has been mostly limited to stations buying their electrical machinery of a certain company. Considering at first what are called the outside wires of the three-wire system, the weights of conductors required for it, compared with those for the 1000-volt transformer system are shown by the ration $(1000)^2 \div (250)^2 = 16$., that is sixteen times the weight of conductors is required for the two outside wires of the three-wire system as for the 1000-volt system; but the third or neutral wire of the three-wire system is usually made of the same size as each of the other two, so that the total weight of conductors for the system becomes $16 \times 1.5 = 24$ times the weight necessary for the 1000-volt system.

The 125-volt system, connecting dynamos directly with lamps, has been used in a few small stations, serving very limited areas; the 250-volt three-wire system has been very largely used by stations buying their electrical machinery from a certain company, and its use would have been much more extensive were it not for the patent limitations above named.

Reasons for the continued use of the three-wire system in many cases, and of the 125-volt system in a few stations serving a very small area, are found in the cost of transformers, which must be added to that of conductors for the 1000-volt alternating system, and in the low all day efficiency of the transformer system.

The low all day efficiency of transformers is due to the fact that a large part of the loss in a transformer remains constant, so long as it is connected to the supply of current, no matter how small its load of lamps, or whether it is operating any lamps at all.

Now, as even quite small central stations must operate from eighteen to twenty-four hours per day, and as most of the transformers have only a very light load or no load during most of the time, the constant transformer losses materially reduce the average efficiency. In spite of the cost of transformers and their low average efficiency under working conditions, the transformer system seemed destined to do the great bulk of incandescent lighting from small and medium central stations, had the maximum practical pressure for incandescent lamps remained at about 110 volts, but happily this is not the case.

For several years back incandescent lamps for from 220 to 240 volts pressure have been regularly on the market, and their advent, marking a new era in central station design, necessitates reconsideration of the advantages of direct and transformer systems of incandescent lighting. Allowing a moderate pressure for the loss in conductors, the new high volt lamp permits the same station pressure as the three-wire system—that is, about 250 volts—and therefore requires the same relative amount of conductors, compared with the 1000-volt transformer system, as is necessary for the two out side wires of the three-wire system, which amount, as computed above, is sixteen times that at 1000 volts. It is evident from the above that a fair decision between the merits of a transformer and a direct system for any given case, must rest largely on the relation between the sum of costs for conductors and transformers for an alternating system, and of conductors alone for a system of direct connection from dynamos to lamps, and also on the operative efficiencies of the two systems. The cost of conductors for the 220-volt lamp is to the cost of con-

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ductors for the 110-volt lamp on the two-wire system as $(110)^2 \div (220)^2 = \frac{1}{4}$; that is, but one-quarter of the weight in conductors is required, and as the three-wire system makes necessary a third wire, equal in weight to each of the other two, the 250-volt two-wire system requires only two-thirds the weight of conductors necessary for the three-wire system, with 110-volt lamps.

To determine, therefore, the best system under the usual circumstances, and free from chances of patent litigation, comparison should be made between the 250-volt, two-wire and the 1000-volt or 2000-volt transformer system.

For purposes of comparison, the cost of electric generators for a given capacity may be taken as the same for either system, though the price of low-pressure generators for the direct work would usually be somewhat lower than those of high pressure for use with transformers. To reach a correct decision as to the merits of heavy conductors alone on one side, and light weight conductors plus transformers on the other, each transmission system should be designed to operate at the same average efficiency during the entire daily run, or at least at some definite efficiency, so that due allowance may be made for difference in efficiencies if any exists. In places of moderate size, the average capacity of transformers which can economically be used is quite small, as individual users usually require but few lamps, and if more than two or three consumers are supplied from the same transformer, the cost of the low pressure wires to lamps becomes too great.

In a plant of moderate size, using transformers, lamps may be assumed to be divided equally between those of forty, sixty and one hundred lamps capacity of sixteen nominal candle power each, and the all day efficiencies of these transformers may be fairly taken at 84, 86 and 88 per cent. respectively.

The average all day efficiencies of above transformers will therefore be $(84 + 86 + 88) \div 3 = 86$ per cent. of the energy delivered to them.

Consider now the cost of conductors on the 220-volt lamp system, and of conductors and transformers on the 1000-volt alternating system to supply one thousand 16-c. p. lamps, taking 55 watts each and grouped at 2500 feet from the station.

The maximum loss in conductors for the direct system at full load may be taken at 14 per cent., or the same as the average all day loss of transformers, although this maximum loss will result in a much lower average loss. With a loss of 14 per cent. in conductors and 220 volts at the lamps, the volts at the dynamos must be $220 \div 86 = 255.8$ and the pressure expended in conductors $255.8 - 220 = 35.8$ volts. One thousand 55 watt lamps consume 55,000 watts, and at 220 volts the amperes must be $55{,}000 \div 220 = 250$.

The area of copper conductors to transmit 250 amperes through 5000 feet of its length with a drop in pressure of 35.8 volts, taking 11 ohms as resistance of a mil-foot of copper is found by the formula for circular mils as follows:

$$\text{C. M.} = \frac{11. \times 250 \times 2500 \times 2}{35.8}$$

Therefore, circular mils = 384070. The weight of a 384070 circular mil conductor, insulated, and 5000 feet long, is about $1308 \times 5 = 6540$ pounds, the weight being about 1308 pounds per thousand feet, and its cost at twenty cents per pound is $6540 \times .20 = 1308.00$ dollars.

Coming now to the alternating system with transformers, the average cost of small transformers may be fairly taken at $1.25 per lamp capacity, so that their total cost for one thousand lamp capacity is $1000 \times 1.25 = 1250.00$ dollars.

As the average efficiency of transformers for all day service is quite low, 86 per cent. in this case, it is desirable to maintain a very high efficiency of conductors in the alternating system, so that the total efficiency of transmission may be as high as practicable. Were there no loss whatever in the conductors between alternating generators and transformers, the efficiency of the system would be lower than that of the direct system on the loss assumed in the direct conductors, since while this loss was taken at its maximum, as equal to the average loss in transformers, its average amount will be much below the maximum and therefore below the average loss in transformers.

It should therefore be noted that while in alternating current transmission with transformers the highest efficiency is at full load, and efficiency drops as load decreases, just the opposite of this is true for the direct system of transmission, in which the lowest efficiency of conductors is at full load, and the efficiency rises as the load decreases.

In consideration of above facts the loss in alternating current conductors for above case may be taken at 2 per cent. for full load, and be less than this at average load.

As one thousand 55-watt lamps consume 55,000 watts, when all lighted, the watts then delivered to transformers, taking their average full load efficiency at 95 per cent., will be $55{,}000 \div 95 = 57893$ watts. To transmit this power over 5000 feet of conductors at a loss in them of 2 per cent. and 1000 effective volts at transformer terminals, requires about 2900 pounds of insulated conductors, which, at 20 cents per pound, cost $2900 \times .20 = 580.00$ dollars. Adding the cost of transformers found above at 1250. dollars and the 580. dollars just found for conductors between generators and transformers, gives a total of 1830.00 dollars, but this does not include any charge for conductors to connect transformers with the lamps on consumers' premises.

With 100-volt lamps a loss of 2 per cent. in wires to transformers, and an average length of 200 feet for these wires, the 55,000 watts consumed by all the lamps require for their transmission about 426 pounds of insulated conductor, which, at 20 cents per pound, amounts to 85.32 dollars, making, with the $1830. above, a total of $1915. for the alternating current transmission system.

The cost of transmission system for the direct current in above case was found to be $1308., so that the alternating system costs 1915. $\div$ 1308 = 1.46 times the direct system of transmission under the fair assumptions above, for a concentrated load at one-half mile from the station. Had the direct system of transmission been designed for the same average efficiency as the alternating, its cost for conductors would have been much less than the $1308 above found, and the increased cost of alternating system over the direct would therefore have been much greater.

Having noted, however, the increased cost of the alternating system for what may be considered ordinary design in each case, it will now be interesting to compare the efficiency of the two systems. The average efficiency of the transformers in above case is 86 per cent., and for the average loss in the two sets of alternating current conductors, with 2 per cent. loss in each at maximum load, about 2 per cent. should be allowed as average loss, making the total transmission efficiency of the system about 83 per cent. on the average.

The loss in conductors of the direct system varies directly as the load on them, and will therefore be 14 per cent. at full load, 7 per cent. at half load, 3.5 per cent. at one-quarter load, and 1.75 per cent. at one-eighth load, of the energy transmitted at each stage of load. It is a fair assumption that full load will last during two-tenths, half load during two-tenths, quarter load during two-tenths and eighth load during five-tenths of the time, in which case the total transmitted energy conveyed at each stage of load may be taken as follows: At full load, $1 \times .2 = .2$; at half load $.5 \times .2 = .1$; at one-quarter load, $.25 \times .2 = .05$; at eighth load, $.125 \times .4 = .05$; the sum of which is $.2 \times .1 + .05 + .05 = .4$.

The part of total energy transmitted at each stage of load will therefore be, for full load $.2 \div .4 = .5$; for half load, $.1 \div .4 = .25$; for quarter load, $.05 \div .4 = .125$; and for eighth load, $.05 \div .4 = .125$.

Applying per cents of loss for the several stages of load, the per cents of total energy lost at each stage of load are: Full load, $.5 \times .14 = .07$; half load, $.25 \times .07 = .0175$; quarter load, $.125 \times .035 = .0043$; and eighth load, $.125 \times .175 = .00218$. The sum of these fractions of total energy is .094 or 9.4 per cent., so that the average transmission efficiency of the direct system is 90.6 per cent. For above case, then, the cost of transmission devices is not only 1.46 times as great with the alternating as with the direct system, but the average transmission loss with the alternating system is 17. $\div$ 9.4 = 1.8 times that with the direct.

The facts illustrated by the above figures seem ample to warrant the growing preference for direct electric distribution over moderate areas.

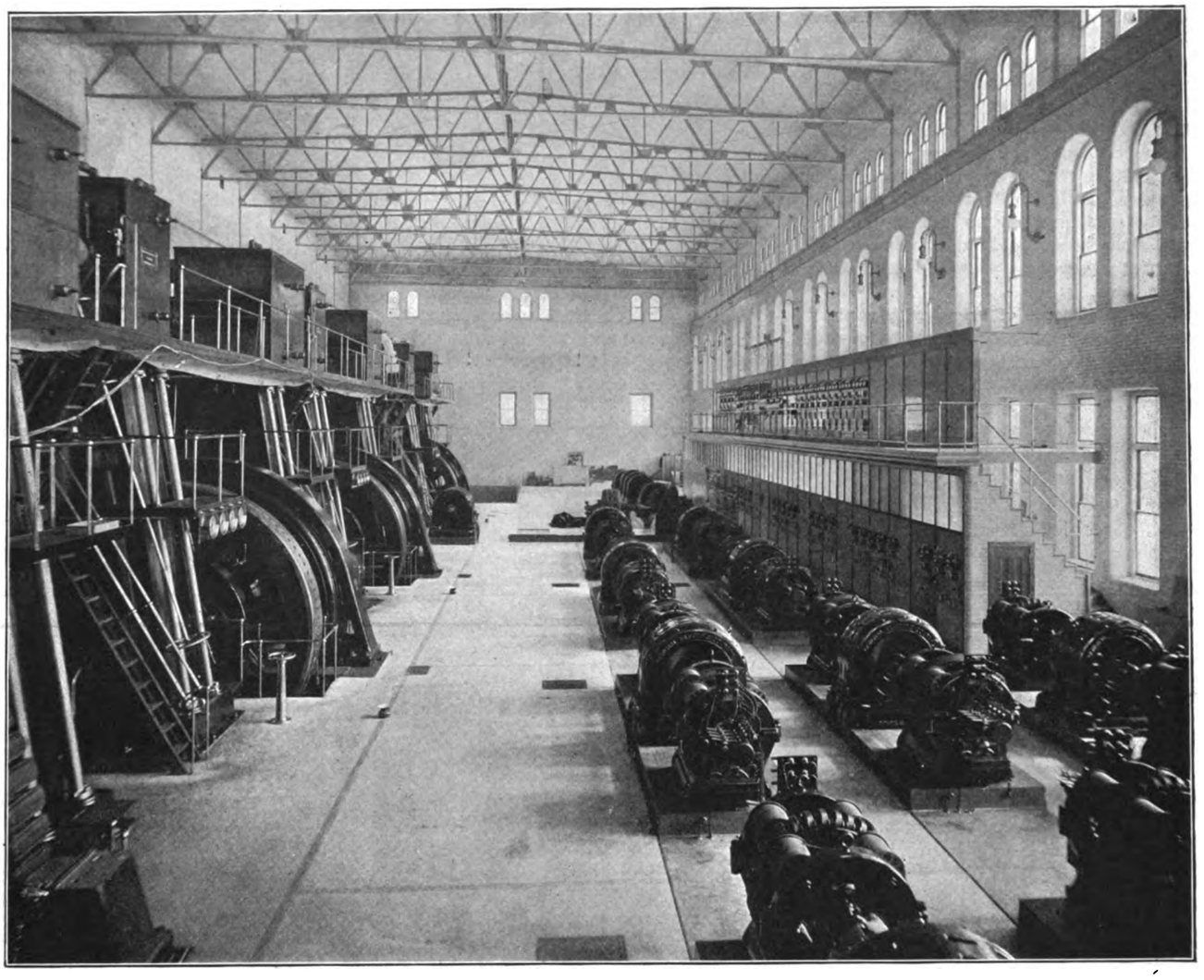
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# CENTRAL STATION OF THE BOSTON ELECTRIC LIGHT COMPANY.

## AN UP-TO-DATE SOLUTION OF THE PROBLEM OF ALTERNATING CURRENT AND SERIES ARC GENERATION AND DISTRIBUTION ON A LARGE SCALE.

In this country the design and construction of alternating current plants as a general rule suffer in comparison with those of direct current plants on the score of permanency, low depreciation and low operating costs. There are several reasons to account for this notable inferiority of the average alternating current installation, among them the older, more developed and more thoroughly standardized condition of direct current machinery and the consequent developments to be expected in alternating current machinery, which make the purchase of expensive alternating apparatus inadvisable. In addition to this is the comparative difficulty of direct coupling alternators to engines, owing to their more rigid requirements of a high peripheral speed, and similar engineering impediments. Alternating current plants have suffered from these conditions, especially where they have been brought into direct competition with the Edison system with its lower depreciation and operating expenses.

A plant in the design of which the factor of long life and economical operation for several decades to come has been studied with more care than it has in any other alternating current central station in this country, is that of the Boston Electric Light Company. Previous to this year the company operated four generating stations with the usual conglomeration of varied types, sizes and speeds of engines, belted to series arc machines and 500 volt dynamos. The new generating station, which will eventually take the whole load of the four old stations, is built in South Boston, on a plot of ground with a water frontage formerly occupied by the historic Harrison Loring shipyard.



A GENERAL VIEW OF THE OPERATING ROOM, LOOKING FROM GALLERY OVER OFFICES.

### THE BUILDING.

The structure is of the now generally approved type for central stations, consisting of two main bays, separated by a fire wall, and each covered with a nearly flat roof of hollow tile on steel trusses supported on steel columns carried up in the brick walls. The building is laid out for a row of six batteries of two boilers each on one side of the fire wall, and six engines on the other side, four of which have already been erected. The boiler room roof spans also an immense coal pocket, separated from the fire room by a wall, which can be eventually removed if necessary, as it does not support the roof spans, in which case another row of boilers could be put in facing the same fire room. The engine room is also wide

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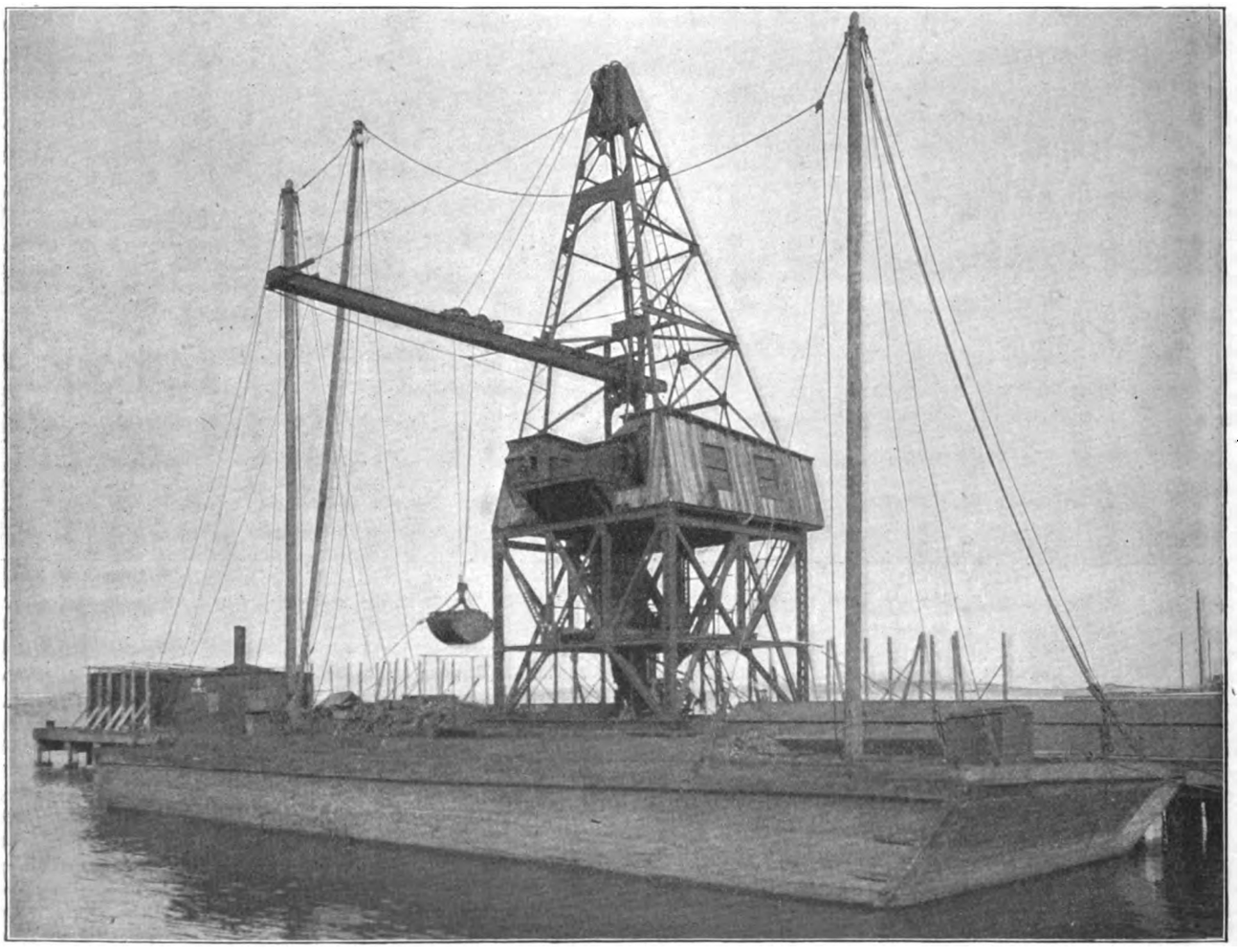
enough for two rows of generators, the space of the second being filled now by motor-driven arc dynamo sets, which it is expected will eventually be displaced by improvements, which will enable arc lights to be carried direct by large engine-type generators without the use of a lot of small series machines.

The rated generating capacity of the four machines now erected is 6,000 kilowatts, which could be increased to 9,000 by the addition of two other machines to the present row, and this could again be doubled to 18,000 kw. in the building now erected by the addition of the other row mentioned; still further increase is provided for by space sufficient to double the length of the building, giving with machines of the type now in use a rated output of 36,000 kilowatts with a 50 per cent. overload capacity. In all probability, however, by the time the load becomes of this magnitude, larger sets giving a greater output per square foot of floor space would be used, giving a still larger figure as the capacity of the area provided for the station. It will thus be seen that the company has allowed a generous provision for future extensions.

The building is of brick, with a plain exterior, on rough stone masonry foundations, carried down to a solid sub-stratum at a depth of about nine feet. Its most striking characteristic is the mammoth brick stack which is 225 ft. in height, with an 11-ft. bore and an octagonal base, 22 ft. between faces at the floor level. Its foundations consists of a grill work of I beams laid in concrete 19 ft. deep. The chimney is capped with cast-iron segments, weighing in all about seven tons. The joints between segments are covered with sheet lead. The space between the

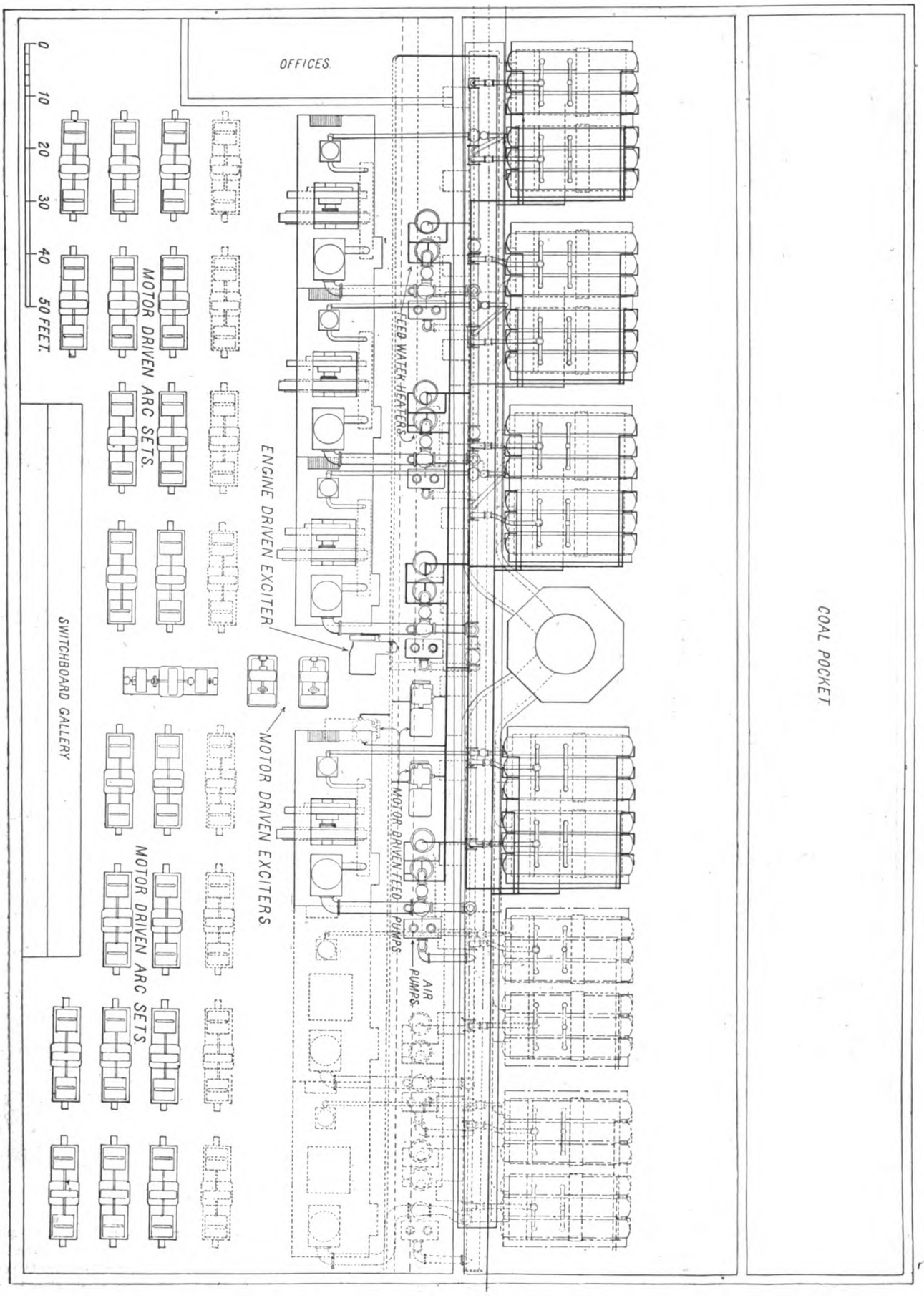


THE 9,000 TON COAL POCKET, SHOWING HOPPERS IN FLOOR, ARCHED WALLS WITH VENTILATING FLUES AND CONVEYOR OVERHEAD.



THE COAL UNLOADING TOWER IN SERVICE.

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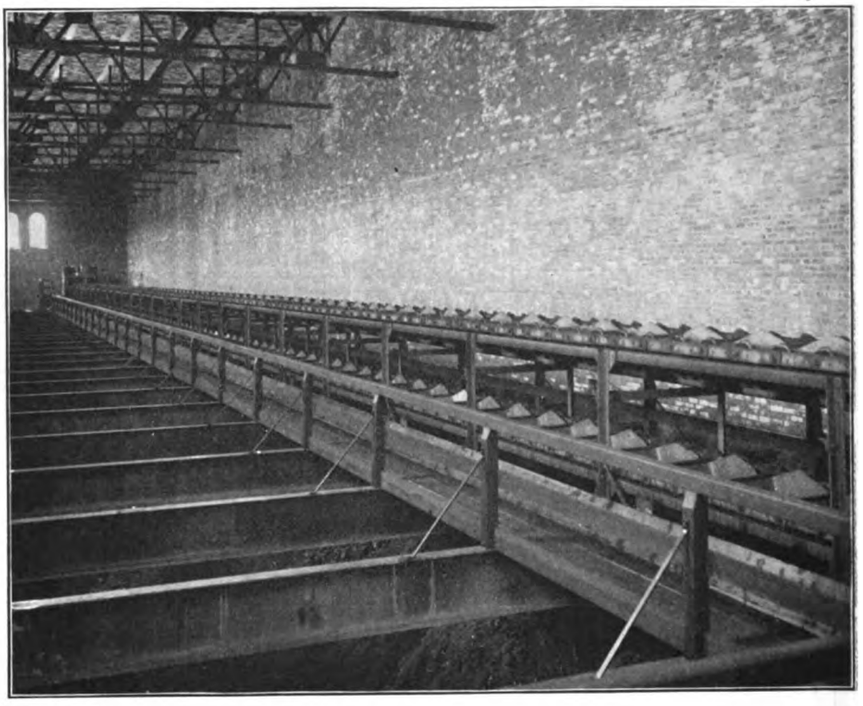

A GENERAL PLAN OF THE STATION.

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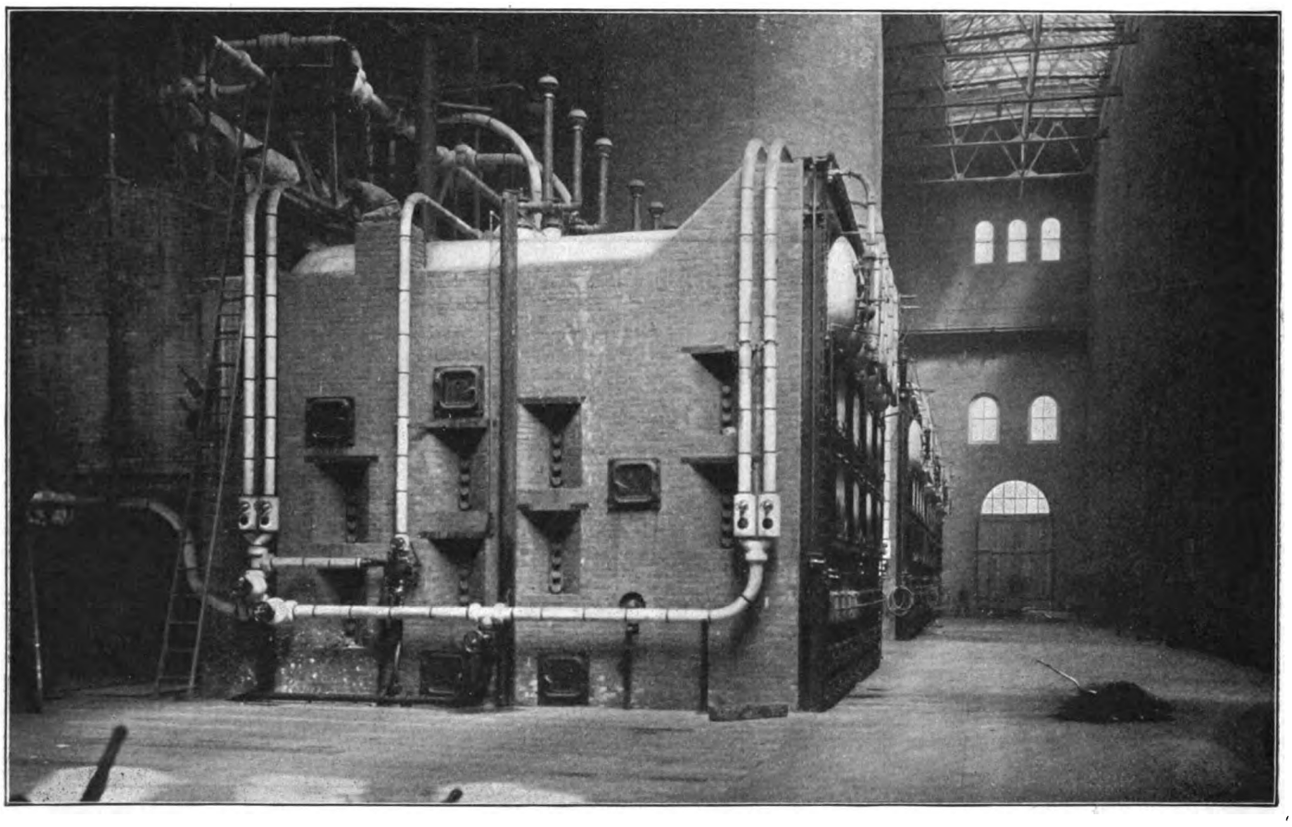
fire brick lining and the shell is utilized as a ventilating flue for the engine room.

The interior of the engine room presents a most striking appearance, owing to the use of white enameled brick for the walls from the floor to the craneways, besides which the underside of the hollow tile roof is plastered with white cement. The windows, of which there is a plentiful supply as the illustrations show, are filled with a form of flock glass which gives no direct sunlight, but gives an admirably diffused illumination. The engine room floor is of terrazzo mosaic. All the machines are painted a dark maroon. The room is lighted by 32 enclosed arcs hung high on the walls, all the wiring to the lights, craneways, etc., being rubber covered and run through hollow bricks embedded in the walls in the proper locations to form the interior conduits. In addition to arcs there are incandescent lamps mounted direct on the engines and on top of the switchboard, in addition to pilot lamps. All wiring from machines to switchboard is in fiber tubing laid in the concrete of the floor, that from main generators being in duplicate in main and basement floors both being in parallel.

All doors are made of wood, covered with about 20-gauge sheet steel, paneled and copper plated, making them fire-proof and less easily dented than tin. The engine room is spanned by a 25-ton crane with two hoists electrically driven.



THE CONVEYOR OVER THE COAL POCKET; DRIVING GEAR AT FURTHER END.

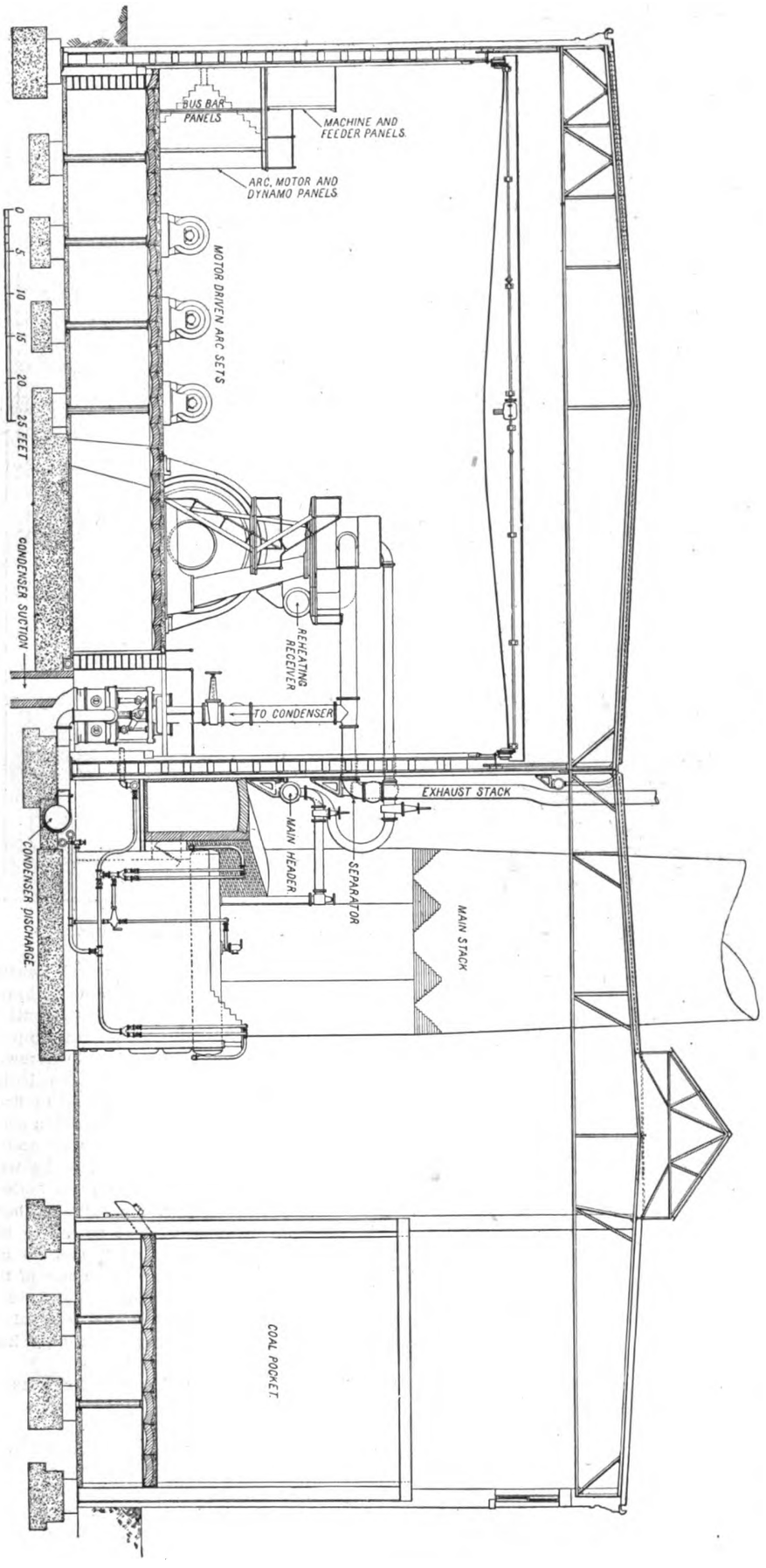


THE BOILER ROOM, SHOWING ARRANGEMENT OF INJECTORS AND FEED PIPING.

### THE COAL CONVEYING APPARATUS.

Running out 150 ft. into the harbor is a pier, carrying a movable tower or crane, from the boom of which coal tubs can be lowered into the holds of the barges or schooners by which coal is transported to New England. The tower was built by the King Bridge Company, and the rest of the coal conveying apparatus by the C. W. Hunt Company. The boom of the unloading tower is swiveled in a universal joint so that its outer end can be swung by hand in a horizontal plane through a small arc to bring it immediately over the hatch into which the tub is to be lowered. The boom can also be run back through the tower to clear the masts

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A SECTIONAL ELEVATION THROUGH BOILER AND ENGINE ROOMS.

of vessels when the tower is run along the pier. It has a capacity of 100 buckets per hour.

Hanging from the trolley on the boom is a one-ton tub of the Rawson patent, the center of which is supported by one tackle and the sides by another. These tackles are hoisted by independent drums and by moving one faster than the other the bucket is opened or closed. The bucket dumps the coal into a hopper over a sloping grate, which sifts out the smaller stuff but sends all lumps over 10 ins. in size to the crusher, from which the coal descends to the filler of the Hunt conveyor. The hoisting gear is driven by a 500-volt motor controlled on the Ward Leonard system, the generator being in the power house with its field rheostat in the tower. The tower itself, when it is moved along the track, is driven by this same motor. A separate motor runs the crushing equipment.

There is no weighing apparatus connected with the tower, the coal being weighed only after it leaves the storage pocket to go to the boiler room. The tower is handled by two men, and is supplied with current from flexible cables fitted with plugs which may be inserted in any of a number of receptacles distributed along the pier.

Running along the pier and up an incline over the coal pocket is the conveyor, which is unusually long, having altogether 742 buckets. The conveyor is driven by a 15 h.p. G. E. induction motor, fitted with rotating resistances and short circuiting devices in its secondary to give it a high starting torque.

### THE COAL POCKET.

The coal pocket runs the whole length of the building, which is 240 ft., and is 30 ft. wide in the clear, giving room for 9,000 tons of coal. The floor is above the boiler room level, so that small cars can be run under hoppers in the floor to carry the coal to the boiler fronts. The walls of the pocket consist of arches sprung between the columns, their convex sides turned inward to resist the outward bursting pressure of the coal. Alternate columns are fitted with cast-iron pipes with bell and spigot ends opening downward, giving ventilating flues by which any gases generated in the coal can escape.

### THE BOILERS.

The water tube boilers are of the Babcock and Wilcox type, triple drum, and with a nominal output of 550 h.p. each on the centennial rating, grouped two in a battery, thus giving each battery a rated evaporating capacity of 33,000 lbs. per hour, sufficient for one of the engines, which are rated at 2350 h.p. each, with a guaranteed consumption of 12½ lbs. of water per h.p. hour. The boilers are fitted with Hawley down-draught furnaces, and run at 160 lbs. pressure. They deliver their gases to the stack through a brick walled flue 6 x 11 ft. in section, and supported on I beams fixed in the boiler room wall and the boiler setting, with a brick arch floor sprung between

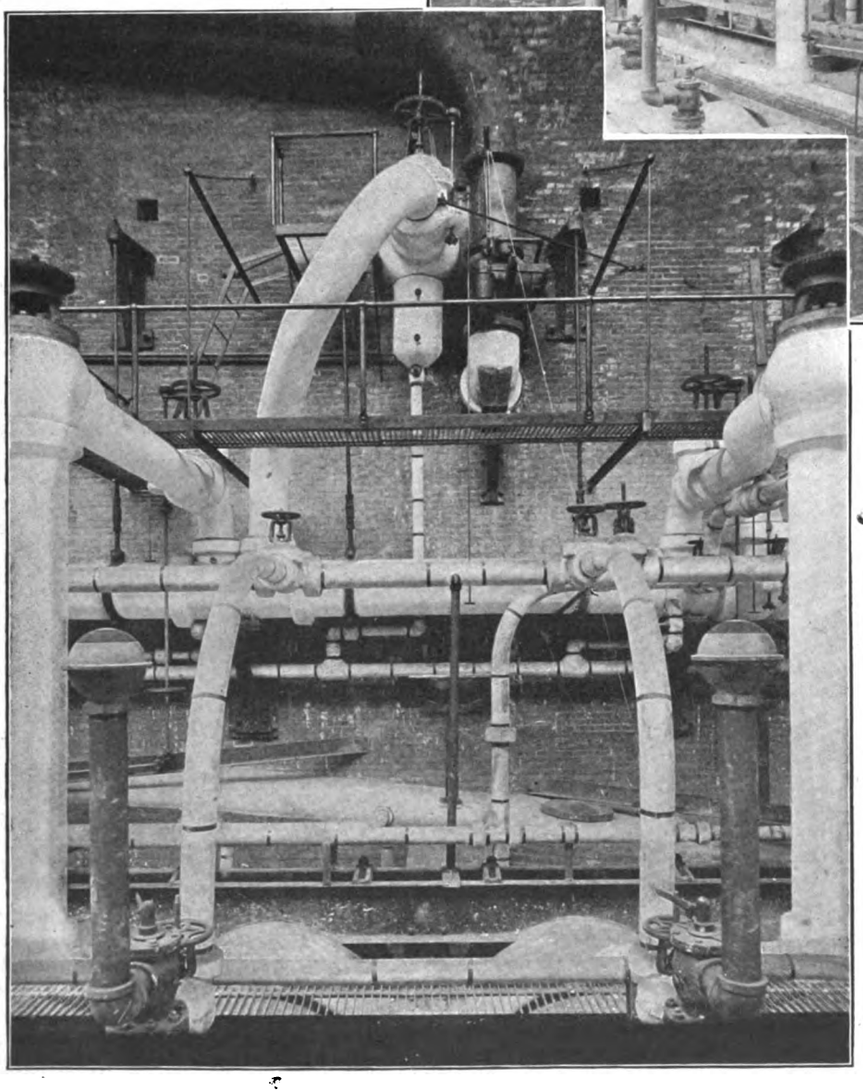
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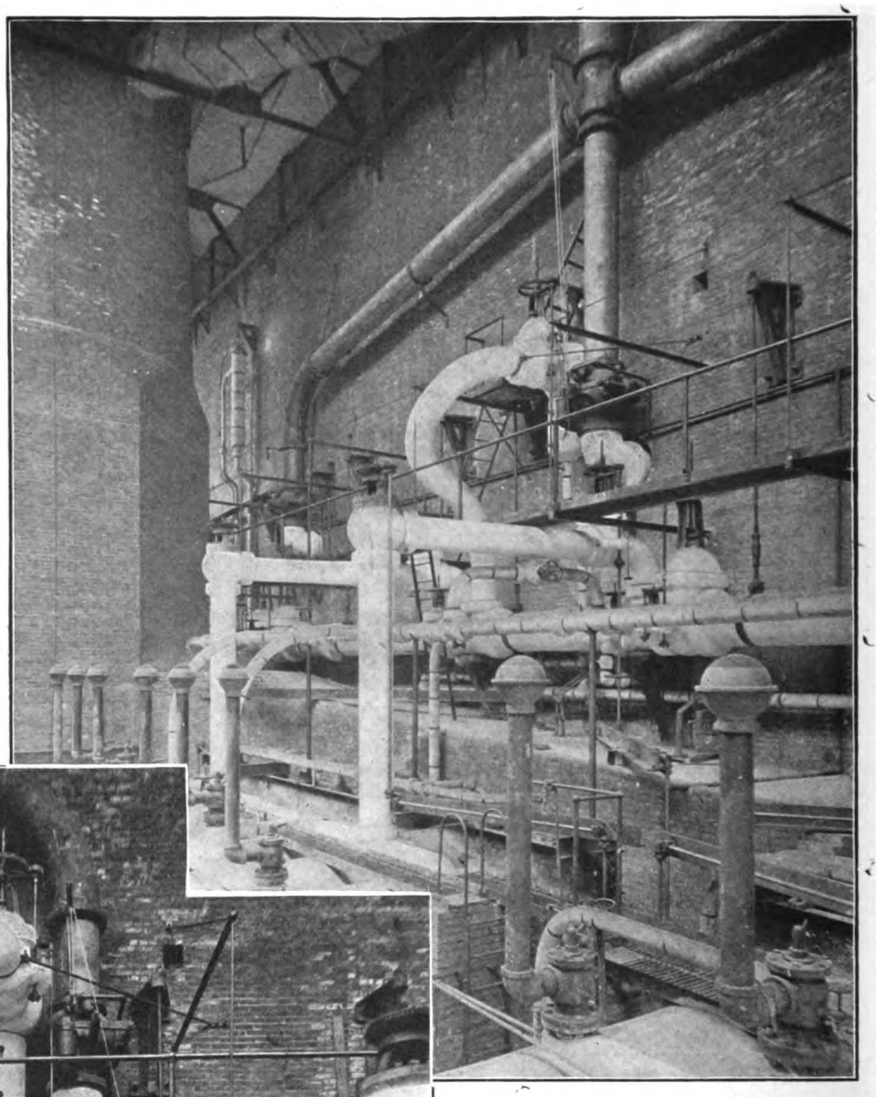
the beams. The flue is lined with fire brick. No economizer is used. The boiler drums are covered with a course of brick and Portland cement, over 2 ins. of magnesia covering. An econometer is installed arranged for connection to any boiler. The cocks of the water level gage glasses are fitted with sprocket wheels carrying chains, which extend down to the floor level, giving a ready means of closing them in case the glass is broken.

THE PIPING.

The steam rises from the boilers through 10-in. nozzles, and passes through Pearson automatic valves which act to check the steam from flowing back into the boilers in case of broken tubes or similar accidents. From these it passes through gate valves and drops into a 20-in. header on the boiler room side of the division wall. This header is hung from brackets and also supported under the tees upon brackets with both transverse and longitudinal slides.

The piping from the boilers comes into special tees in each of which are two nozzles, one of which delivers steam to a





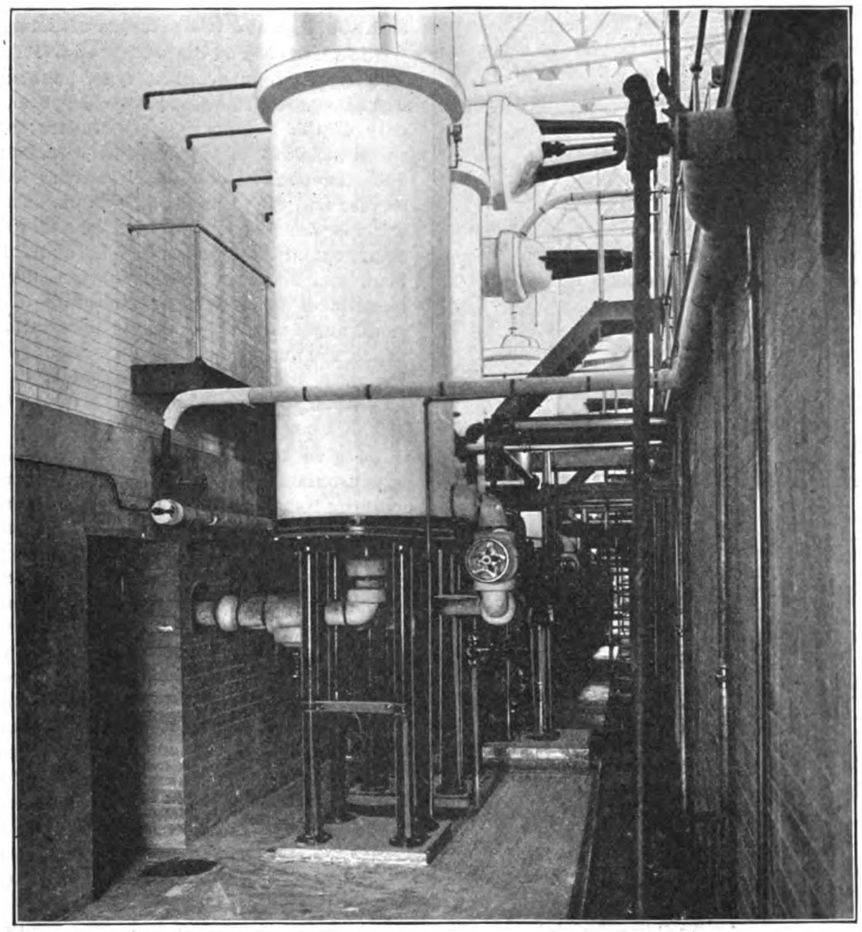
THE PIPING OVER THE BOILERS.

copper bend or loop rising and passing through a gate valve into a Cochrane separator and thence through the wall to the engine stop valve. The steam piping is all of lap-welded steel with screwed flanges. All the valves in the boiler branches are geared down to the floor level, and those in the engine branches and in the header itself are connected with gearing running through the wall into the engine room at a convenient height. Besides this, a gallery has been built to give convenient access to the valves themselves. The header is anchored at the center, and each side of the anchorage has a gate valve, the purpose of the two being to allow the removal of either one by shutting down only half the plant.

The engines discharge their exhaust steam through 24-in. pipes, which run back into the boiler room and there combine in groups of three to an atmospheric riser. On the engine room side of the wall each exhaust branches downwardly through a 24-in. motor driven gate valve to a jet condenser via a surface heater fitted with a by-pass.

The condensers draw their cold water

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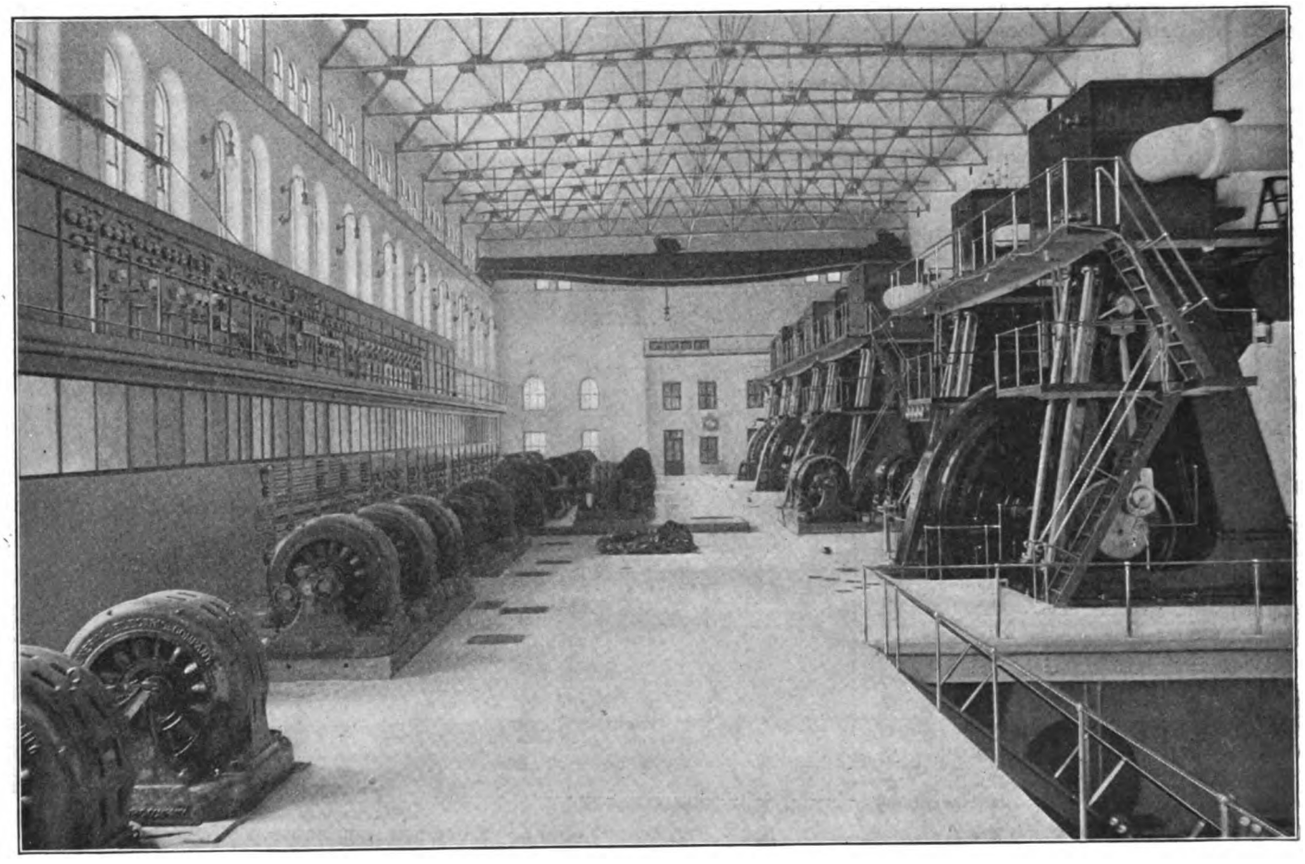
THE FEED WATER HEATERS.

from a sluiceway 7 ft. in height and 3 ft. in width, running in from the harbor front and discharge into Blake vertical twin air pumps, controlled for constant speed by Mason regulators and delivering their hot water to a 36-in. discharge main buried in concrete, running out again to the harbor. City water is used for boiler feeding, and is handled by the elaborate system described below, equipped entirely with drawn brass piping and cast brass fittings.

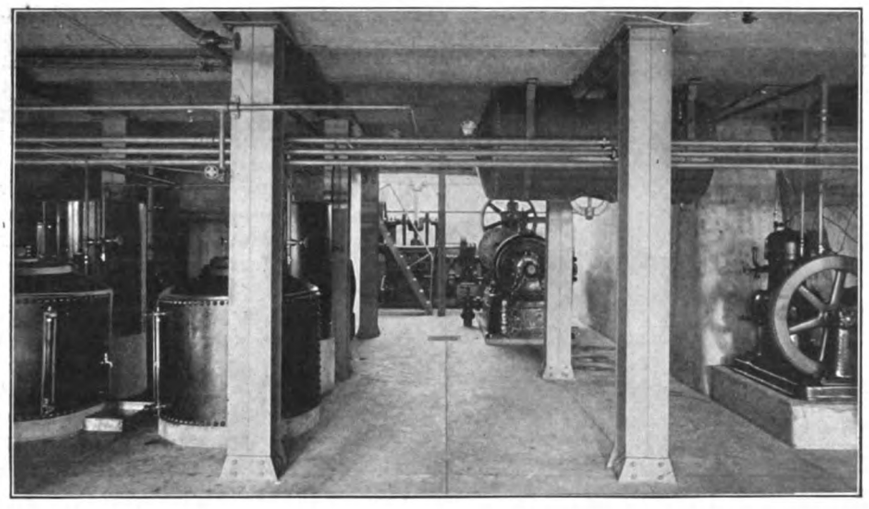
Three Gould's triplex pumps with a capacity of 200 gallons per minute each are driven through triple reduction gearing by 30 h.p. induction motors, and draw water from a supply main and force it into a 6-in. feed main, from which it may pass through the feed water heaters or direct to the boilers.

The pumps are kept running at constant speed, and the feed is controlled by hand operated by-passes. The water passes first through the main heaters described above, and then in series through auxiliary heaters, one for each engine (taking the exhaust of the air pumps and other auxiliaries), and thence through branches to either the front or rear of the drum of any boiler. A reserve source of feeding is obtained by means of an injector at the side of each boiler so piped that it may feed that or any other boiler direct from the city mains.

The usual piping for the purpose of wetting ashes and washing the boiler may be fed through a pump by which its pressure can be raised to work hydraulic flue cleaners, besides which it is fitted



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THE OILING SYSTEM; OIL TANKS TO THE LEFT, AIR RESERVOIR OVERHEAD AND AIR COMPRESSOR TO THE RIGHT.

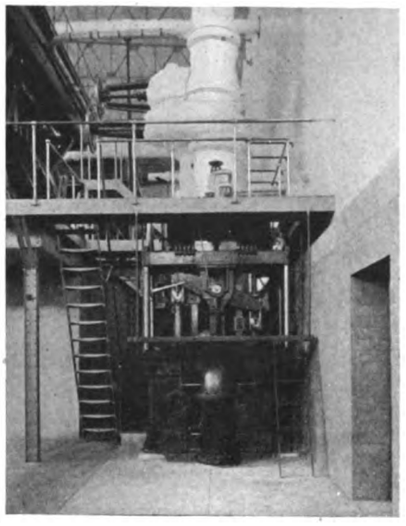
with a standard gage by means of which the boiler gages can be calibrated. All steam piping is drained by means of the Holly gravity return, and is, including the flanges, protected with magnesia covering.

The lubrication or oiling system comprises three 400-gallon pressure tanks in the basement below the dynamo room, two for engine and one for cylinder oil. An air pressure of about 20 lbs. per square inch is kept upon these tanks by a motor driven air compressor, which is also piped to hose connections for blowing the dust off the machines, switchboards, etc. The two engine oil tanks are provided to keep one in service while the other is being filled. The air pressure forces oil from them to one tank on the cylinder platform, which feeds the cross-head slides, etc., and another tank on each main bearing. The drips are carried to Cross oil filters fitted with steam heating pipes. New oil is introduced into the system by the simple process of tapping the barrel into the tanks, and applying the compressed air pressure to it, forcing the oil up and into the tank.

The main journals of the engine are water jacketed, and the water passing through them is returned to the pressure main by a small pump controlled by a float valve.

### THE ENGINES.

The engines are vertical cross compounds with a rating as noted above of 2350 h.p., this being based upon a 23 per cent. cut-off, over and above which there is a large overload margin as the maximum obtainable cut off is some 75 per cent. of the stroke. The engines run at 120 r.p.m., the speed necessary for the 60 cycle alternators to which they are coupled, and have a piston speed of almost 1,000 ft. per minute. They are of the open front marine type, the cranks and the connecting rods being housed in with sheet iron casings to prevent the throwing of oil. Each is provided with a 50-ton, 16-ft. fly wheel and shaft governor within its hub, controlling the cut-off valve in both the high and low pressure cylinders.

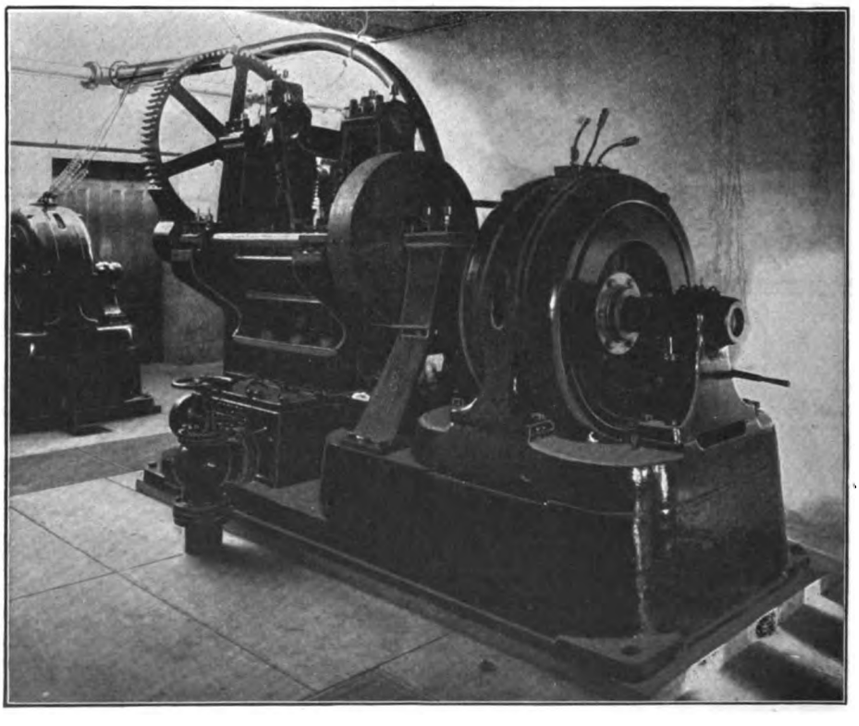


ONE OF THE AIR PUMPS.

The valves are of the well-known McIntosh & Seymour gridiron type, running across the cylinder heads. The heads only of the high pressure cylinders are steam jacketed. Steam from these jackets goes through coils in the reheating receivers and then into Holly system. The engines are guaranteed to give a 2 per cent. regulation between no load and full load, and also, on account of the large number of poles of the generators and small angle required to throw them out of phase, are guaranteed to give a maximum variation from the main position of uniformity of rotation throughout a stroke of 1-10 of 1 degree.

To give the proper speed control in synchronizing, *i. e.*, to bring an engine running light down to the speed of others running loaded, in order to throw the generators in parallel, the governors are fitted with speed controlling devices which can be set by hand to adjust the speed through a range of several per cent. This device consists essentially of a leaf of the governor spring, the bending moment of which can be changed by means of a rather elaborate slipping collar, friction wheel and screw device; with this arrangement a distribution of the load between the engines can be changed at will while they are running.

Mr. F. A. Gilbert is President of the Boston Electric Light Company, and to him and Mr. Sidney Hosmer, Assistant General Manager, is due the credit for the main features of the design of the splendid new station. Mr. H. W. Ball designed the structural details of the building, and Mr. Herbert Houghton served as resident engineer. Mr. James T. Boyd designed the details of the mechanical equipment.

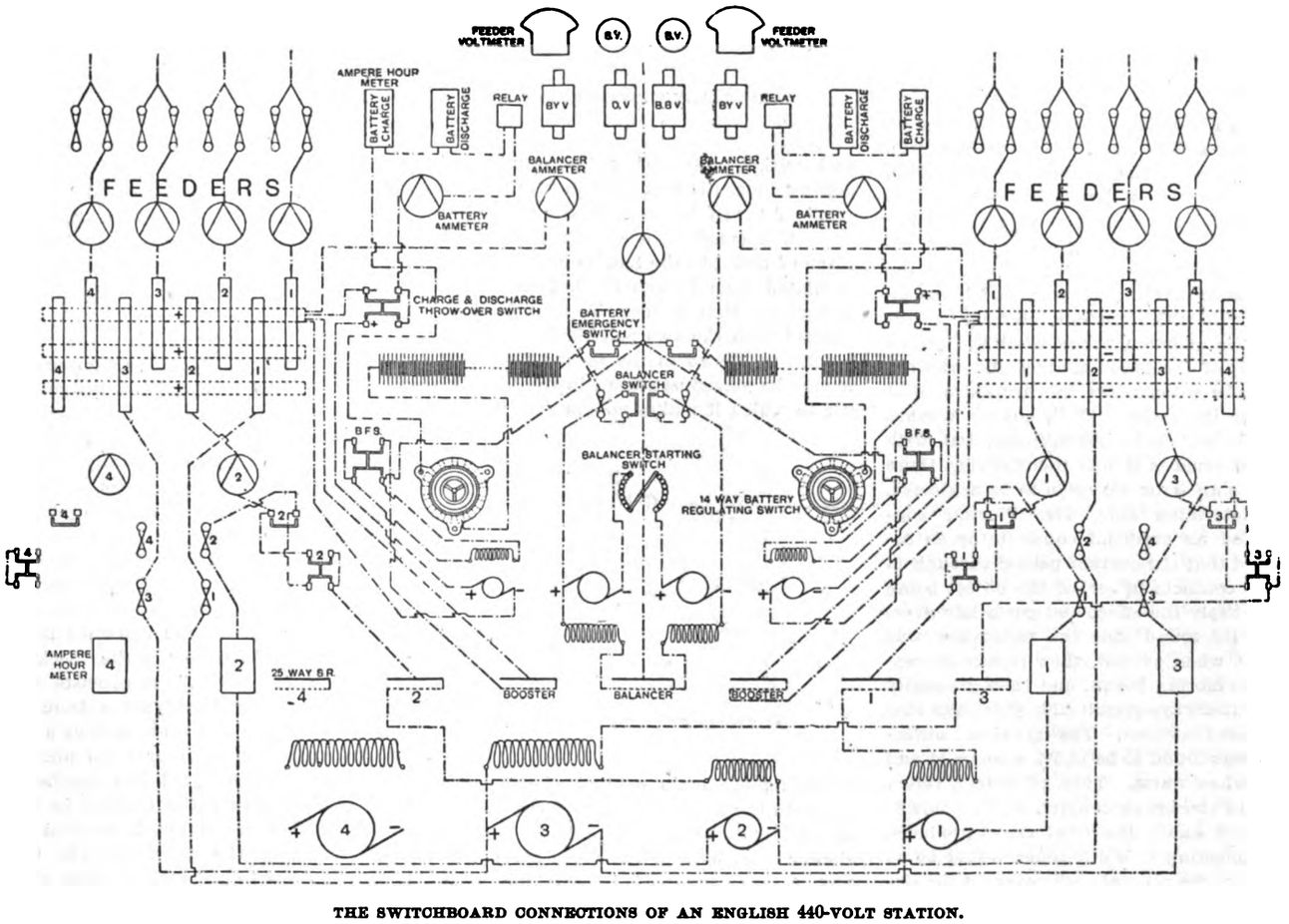


ONE OF THE BOILER FEED PUMPS.

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# Among our Foreign Contemporaries

**440 Volt Lighting Station in England.**—A small central station has just been started in the Borough of Bootle, in England, of which very full descriptions are given in the English journals; it is of interest as a sample of a modern plant in that country, and more especially so because it is constructed for 220 volt lamps, which seem to be growing in favor in that country quite rapidly. The population of the place is 54,000 and the total capital expenditure of the station is $185,000, the total connection of lamps at the present time is equivalent to 7500 lamps of 8 c. p. The station is located near a canal, which insures a cheap supply of coal and water. All the buildings are on one floor, which has a base of two feet of concrete; the chimney is 150 ft. high. The three wire continuous current system is used, with 220 volts on each side; there are also balancing transformers and boosters for charging the batteries. The boilers work at 160 pounds pressure and an economizer operated by an electric motor is used. The engines and dynamos are direct connected, there being two of 75 kw. and one of 150, the small ones running at 450 revolutions and the larger at 380; the dynamos are shunt wound and will give any voltage between 440 and 500. Condensers are used in connection with the engine. The balancing transformers and boosters are coupled together in one line, the former being capable of balancing the whole system to within four volts when a current of 100 amperes flows through the middle wire. The boosters are arranged to give any voltage from 10 to 75 with a current up to 130 amperes. An illustration of the connections of the switchboard is shown in the adjoining cut, which is reproduced from the London "Electrician," from which this description is also taken. It is arranged for four dynamos, four feeders, one balancing transformer and two boosters, and also for the middle wire connections from two of the four feeder points. The middle wire is permanently earthed through a recording ammeter. The three panels are of slate and are carried in steel frames cased in on the outside with varnished teak. As is seen, the left hand panel contains the positive connections, the right hand the negative connections, and the middle panel the connections for the middle wire, balancing transformers and boosters. In the circuit of each dynamo there is one minimum current circuit breaker arranged to drop when the current falls below 10 amperes, and interlocked with this is a shunt switch, by which the field is closed through a non-inductive resistance when the circuit is open. The regulating switch for the shunt coils of the dynamo is 25-way. One ammeter is connected in each dynamo circuit and two ammeters in each feeder circuit. At the back of each outer panel there are three horizontal bus-bars, the two upper ones being provided with screw-holes placed opposite the plug holes in the vertical feeder and dynamo bars, and the lower one being provided with screw-holes placed opposite the holes in the dynamo bars only, so that any dynamo may be connected to the traction board. In the center panel there is one double pole starting switch and fuse in the circuit of the balancing transformer, interlocked with the starting rheostat, two rheostats for the transformer fields, an ammeter in the circuit of each balancing transformer, a middle wire ammeter, and the recording ammeter already mentioned. In each battery circuit there is a single way charge and discharge switch, a battery ammeter, a registering meter reading directly in ampere-hours, one battery emergency switch, and one single pole throw-over switch for connecting the battery either to the booster or to the mains. There is also a regulating rheostat for the booster fields. An ammeter registering ampere-hours is fixed in the circuit of each dynamo, and there




THE SWITCHBOARD CONNECTIONS OF AN ENGLISH 440-VOLT STATION.

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are two recording voltmeters for registering the pressures at the feeding points. There are 125 chloride cells on each side of the middle wire and they can maintain a discharge of 100 amperes continuously for five hours, or 300 for one hour, with a final voltage of 1.86; the cells are in glass boxes resting on wooden trays and supported on glass insulators. The network of wires is fed at four feeding points; the cables are insulated with paper, are lead covered and are run through earthenware troughs, all laid in bitumen. The public lighting includes 92 arc lamps of 10 amperes each, each lamp post having also two incandescent lamps of 16 c. p., which are switched on at midnight when the arcs are turned off. The arcs are connected four in series on the 220 volt mains. The Wright system has been adopted at the rate of 14 cents for the first hour of maximum demand and then 6 cents thereafter.

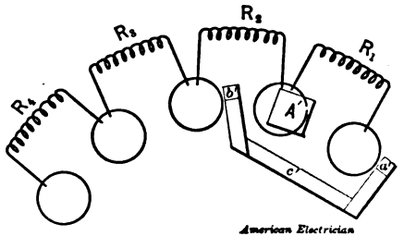
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**Brush Resistance in Measuring the Efficiency of Dynamos.**—In using the well known Swinburne method for measuring the efficiency of a dynamo, which consists essentially in running it as a motor unloaded and measuring the current required, it is necessary also to know the resistance of the armature, and in measuring this with a current and drop in voltage, the question arises what the resistance is of the brush contact and whether it is the same when the armature is at rest or in motion. With copper brushes this difference is insignificant, but with carbon brushes it was thought that there may be an error too large to be neglected. To determine this, Mr. Pierron constructed an artificial commutator so arranged that the current passed through 14 brush contacts in series, the object being to multiply the effect and get a fair average. He found that the resistance was lowest when at rest, then increased rapidly as motion began, and then gradually fell, but always remained higher than that measured at rest. The greatest difference was found to be 13.5% when cold and 18% when warm. This, of course, refers only to the brush contact, and as this is in itself small, the total error produced by neglecting this difference would be so small in the ultimate efficiency of the dynamo that it may be neglected, and it is therefore safe to measure the brush resistance when the armature is at rest, even with carbon brushes.

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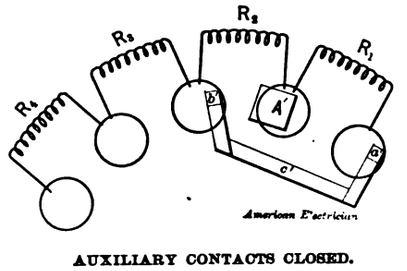
**Total Length of Telegraph and Telephone Wires in the World.**—From a recent table of statistics, published in the foreign journals and taken from official sources, it appears that there were at the end of 1898 2,029,893 miles of telegraph and telephone lines in use in the world, of which 167,800 miles were submarine cables and 382,417 were for telephones. The corresponding figures for the mileage of the wires as distinguished from the lines are as follows: 8,285,400, 169,600 and 3,202.950.

**Improvement in Step by Step Resistances.**—In the usual form of adjustable resistances in which a lever arm moves over a succession of contacts between which resistances are connected, it is often desirable to have smaller variations of resistances than those between the steps; to do this in the original construction of the instrument involves making it larger and more expensive. A very simple way of doubling the number of steps even after the apparatus has been made




AUXILIARY CONTACTS OPEN.

and without increasing the number of contact blocks is described in "L'Electricien." As will be seen in the adjoining figures, it consists in adding a U-shaped piece of metal to the handle or crank, but insulated from it, and placing it in such a position that it may be brought into contact with the two neighboring contact blocks, as shown in the second figure, or it may be placed as shown in the first figuse in which it makes no contacts, A rep-




AUXILIARY CONTACTS CLOSED.

resenting the main contact of the lever arm. In the position shown in the second figure it will be noticed that the two resistances on both sides of the main contact, A, are connected in multiple with each other, thus diminishing the resistance. This arrangement enables one to nearly double the number of steps, as it gives an additional value between each two blocks. Where small variations in resistance are desired, as for instance in regulating the lights for a stage, or in adjusting the resistance of feeders in multiple, etc., this arrangement seems to be a very convenient and simple one.

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**Reducing Transformer Losses.**—As is well known there is always a continuous loss in the primary of a transformer, whether there is a current in the secondary or not; this loss, although small, is continuous, and amounts to considerable in the year. Numerous devices have been suggested for diminishing it, such as cutting out the transformer when not in use, but few, if any, are used in practice. One method of some interest is to divide the primary and secondary each into two equal parts and couple them in multiple for full load and in series for small loads. The transformer ratio will, of course, remain the same in both cases, but the induction will be reduced to a half for a series connection, the loss due to hysteresis will be reduced more than a half and that due to the heating of the current is increased only slightly, so that altogether there will be an appreciable gain in economy. A somewhat similar system, but applicable only to three phase circuits, was recently described by Kahlenberg in "L'Industrie Electrique." It consisted simply in connecting the three coils first with the end of one to the beginning of the next, forming what is called the triangle or delta system of connection, and then change them to what is known as the star of Y system of connection. In the first case the voltage will be 70% greater than in the second, and the triangular coupling is therefore used for large loads, while the star couple is used for small ones. The change must, of course, be made simultaneously in both the primary and the secondary circuits, so as to retain the same transformer ratio.

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**Simple Method of Testing Dynamos.**—The dynamo being less liable to get out of order than the engine and boilers, it is customary in a central station to test only the two latter periodically. While this may suffice in most cases, it is advisable, also, to test the dynamo periodically, as in that way any faults developing in it may be noticed before any harm is done. A very simple and quick method of doing this so as to find any changes in the efficiencies of the dynamos is described by Mr. Liebenow in the "Elektrotechnische Zeitschrift." It consists simply in uncoupling the dynamo from the engine or turbine and running it as a motor from the bus bars or from another machine until its speed has reached a certain fixed value; the current is then broken and a stopwatch is started the same moment; the machine will then gradually come to rest and the time which this takes is noted on the stopwatch. If this is done when the machine is new, then at any future time the condition of the machine with respect to the internal losses may be found by making a similar test. The test may be made with the field excited or with the field open and with the brushes on or off, thus giving an opportunity to test the effect of each. If the bearings are not in good order these tests will show it, or if the brush friction has become too great it will be noticed in that test. With the field excited, the armature will come to rest sooner, as the Foucault current losses will then be added to the friction losses in bringing the machine to rest. If not convenient to measure the time with a watch, the number of revolutions made after the current is

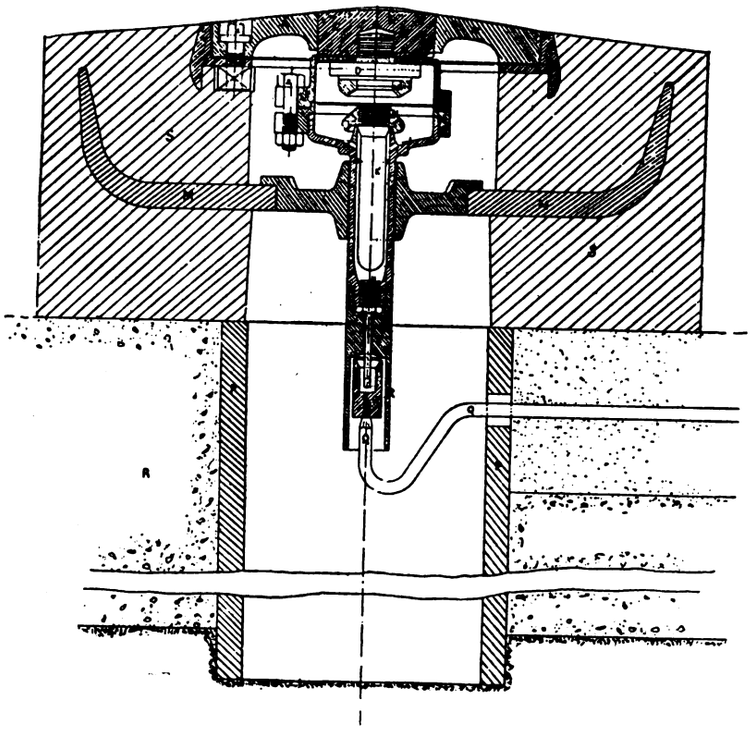
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cut off may be counted by means of a revolution counter, for which purpose an ordinary bicycle cyclometer or similar instrument could be used, care being taken to start the counter at exactly the moment that the current is shut off. In the case of a small dynamo from which the belt can be readily thrown off, it may be brought up to speed by means of the belt instead of using current from an external source. By repeating the test with and without excitation and with and without the brushes a fair idea can be obtained of the Foucault current and hysteresis losses, that due to the friction of the brushes and that due to the bearing and air friction.

Some years ago a similar method was described for measuring the actual instead of the relative efficiency of a dynamo, but it is necessary in that case to know the moment of inertia of the armature, and as this is a troublesome quantity to deal with, the test was repeated with and without a heavy flywheel, and from these two tests the efficiency can then be calculated.

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**Surface Contact System.**—In many of the cities in Europe the overhead trolley wires are objected to for aesthetic and other reasons, and more attention is therefore paid in those cities to the development of the other systems. The surface contact system is one of those which has rarely been installed, although probably a hundred systems have been invented. An installation of this kind which has just been completed in the city of Tours, in France, and is described in "L'Electricien," is therefore of interest. In this the Diatto switch is used. The total line is three miles, but on the part outside of the limits of the city the overhead trolley system is used. It was completed in April and is said to operate very successfully. It is said to be noted for the great simplicity and the reliability of its operation. The mechanism of one of the contact plates is shown in the adjoining illustration. The actual contact plate is the middle portion, C, on the lower side of which is secured a carbon block with a conical hole, which may be brought into contact with the movable plunger k, which is also mounted with a cap of carbon at the top. Whenever the car is over one of the plates this iron plunger, which floats in a tube containing mercury, is, by means of magnets on the bottom of the car, attracted so as to establish contact, and the moment the car has passed, the weight of that plunger breaks the contact again. The contact block is surrounded by a large block of asphalt S through which extend the soft iron pieces M; these form part of the magnetic circuit, as there are three bars or skates on the bottom of the car, the middle one being the north pole and at the same time the contact skate; while the two outside ones are south poles and their magnetism passes through the prongs M, to the hard rubber tube containing the mercury, and the plunger connection with the mercury is made by means of another mercury cup shown in the lower part of the cut, which is open only at the lower end and is connected with the feeder Q; the object of the latter arrangement is to prevent water from rising to the contact in case the pipe P should become filled with water. The contact plates rise only three-quarters of an inch above the surface of the pavement; the pipe P is for draining the opening; the cup A is of a non-magnetic material. The skate carried on the bottom of the car is composed of three bars, only the middle one of which makes contact, and is at the same time the north pole of a magnet; the two outer bars, which pass over the ends of the bent pieces M, are both south poles. The magnets are excited by the main current, but in order to start the car and to maintain contact if the current should be broken, a small storage battery is carried on the car, and its current flows continually through the exciting coils; this battery yields five to six amperes at 30 to 32 volts. Graphitic carbons of a very pure kind are used for the contact blocks and the contacts are said to be very good; there is said to be no sparking or arcing there, and as the carbon used is very pure the blocks do not stick together. The battery current continues to flow all the time except when there are long rests in the daytime or when there are no lamps lit in the car. This system has also been adopted for L'Orient and Reims, and it is also to be used on one of the lines in Paris.



THE DIATTO SECTIONAL CONDUCTOR SWITCH.

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**Separating Foucault Current Losses from the Others in Dynamos.**—The efficiency of a dynamo is easily determined when all the losses are measured together, but some times it is desirable to separate the Foucault current losses from the others. A simple method for doing this was devised some time ago by Kapp, and is described incidentally in an article in the "Elektrotechnische Zeitschrift." The dynamo is excited with a constant current, and a current from a separate source is passed through the armature, running it as a motor. This is done for a number of different speeds, the more the better. When the speed in each case has become constant, the voltage and current in the armature circuit are measured, besides the speed. The products of the voltages and amperes give the amount of power required for overcoming all the losses, and of these the friction and hysteresis losses are directly proportional to the speed, while the Foucault current losses are proportional to the square of the speed in revolutions per minute. If, therefore, the watts obtained as above described are divided by the speed, the results will still be proportional to those losses; the numbers thus obtained are made up of a constant quantity, a, which is proportional to the internal losses, except those due to Foucault currents, and another quantity, by which is proportional to the Foucoult current losses, the air losses being neglected. By means of algebra, or by trial, or with the aid of a diagram, these quantities may then be separated. To do this by algebra use the equation

$$k = a + bv$$

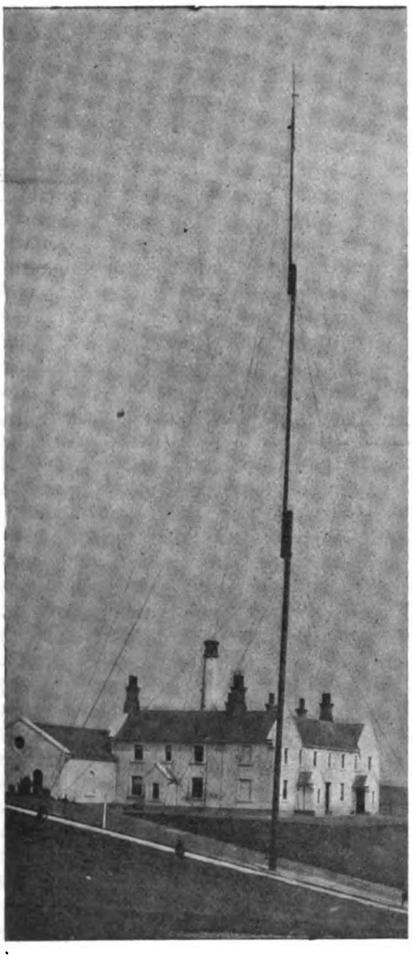
in which k is the quantity obtained by dividing the watts by the speed. By substituting in this the values of k in two cases and the speed for the quantity v, the two equations may be solved for a and b, and by then multiplying a by the

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speed v again, all the losses except those due to Foucault currents are obtained; and by multiplying bv by the speed v the Foucault current losses will be obtained, both in watts. The same results should be obtained from the data of any other two tests. To solve it graphically lay off the curve represented by that equation, k being the ordinates, v the abscisas. A straight line will be obtained cutting the k axis above the origin. The value of a is then equal to that distance, while b is obtained by subtracting a from any of the ordinates and dividing by the corresponding speed v.

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**Wireless Telegraphy.**—One of the great objections to the system of wireless telegraphy, about which so much is written at present, is that the electromagnetic waves sent out from the transmitter ex-



THE MAST AT SOUTH FORELAND.

tend in all directions like the sound waves from an explosion, and are therefore received by any and all of the other stations. Great confusion would therefore result if there was more than one plant in use. It is now announced in the English journals that Marconi has succeeded in devising what is called a selective system, that is in sending messages to any one of the four stations which now exist on the English Channel. Unfortunately it is not described how he accomplishes this, but it is of interest to know that he has actually succeeded in doing it in practice.

The accompany illustration, taken from the London "Electrician," shows the mast at the South Foreland station, which is required for the vertical wire, which seems to be the essential element of novelty in the Marconi system. This mast is 150 feet high and is intended for transmission across the English Channel in a place where the distance is 30 miles. He states that the height of these masts varies about as the square root of the distance, that is, for double the distance the two masts would have to be half again as high. He has found no difficulties due to the curvature of the earth, but does not know anything about the attempt which it is said will be made soon to telegraph across the Atlantic Ocean, nor does he approve of trying it at the present time. The apparatus of the South Foreland lighthouse is shown in the second illustration and will be seen to be surprisingly simple. The speed of transmission has now reached about 20 words per minute. Marconi agrees with the statement frequently made by others that his system is not likely to take the place of the usual telegraphy by wires for long distance commercial work, but its field is for telegraphing to islands, light ships or other places separated by the sea, and for this it is now available up to distances of 60 and 70 miles.

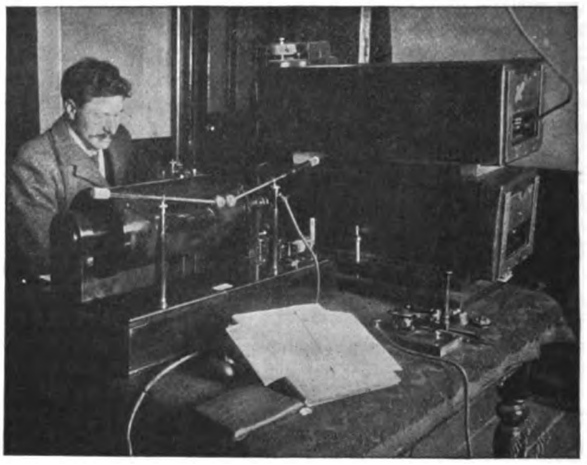
Marconi himself is quite a young man, being only twenty-five years of age. He was born in Italy, but his mother is English. When he first arrived in England with his instruments they were mistaken by the custom authorities for bombs or infernal machines and were broken up, thus rendering them quite useless.

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The coherer, which is the detector of the electromagnetic waves used in wireless telegraphy, and which is the secret of the success of this system, is really quite a simple piece of apparatus, and it seems, from a recent experiment described by Prof. Blondel, in a note in the London "Electrical Review," that a coherer even better than that used by Marconi may be made by using alloys instead of mere mixtures; and moreover, that the best alloy is that of which the American nickel is made. One has, therefore, only to take a five-cent piece and file it in order to get what he considers the best knd of filings for a coherer. He also improved the instrument by making a side tube or pocket in the containing tube and filling it with these filings, the idea being that when those in use became fatigued by long action, the coherer may be freshened up by shaking it, so as to bring new filings into action.

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**Long Spans of Overhead Wires.**—In calculating the strain and sag of wires, an approximate formula is generally used in order to simplify the calculations, but for long spans the error committed is too great. Prof. Juellig, in an article in our Viennese contemporary, the "Zeitschrift fuer Elektrotechnik," therefore calculated the data by the correct formula and obtains among other information the following figures giving the maximum spans possible for wires of different materials, on a basis of a factor of safety of four. For cast steel wire, 3.42 miles; for silicum bronze, 1.56 miles to 1 mile, depending on the quality; for wrought iron, 1.02 miles, and for soft copper, .53 miles. These maximum spans are independent of the cross section of the wire, for although the weight of the wire increases with the cross section, its strength increases in the same proportion. These spans do not allow for wind pressure, or for snow or ice, and the sag, being that to give the least strain, is quite great, in the case of the steel wire, for instance, it is 1.2 miles, and such a span would therefore be impracticable except from the tops of mountains. The figures are of value merely to show the possible limits.



THE APPARATUS USED BY MARCONI.

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**Electric Automobiles in Paris.**—The first public electric vehicles have recently been started in Paris, and in course of another month it is expected that there will be 100 in use. The charging station and stables are designed for a capacity of 1000, and it is thought that in the course of a few years as many as 4000 will be in use. Some data and external views of these carriages are published in "L'Industrie Electrique," from which the following data may be of interest. To change the batteries for fresh ones at the stables requires only three minutes. The weight of a carriage which is intended for two people besides the driver, but will seat

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two more by means of a folding seat, is 5000 pounds, including the useful load of about 600 pounds, which presumably refers to four passengers, the driver being included in the dead weight. The useful load is therefore only about 12% of the total weight to be carried. Pneumatic tires are used only on the front wheels, the rear wheels, which are larger, having cushioned tires. A battery of 44 cells weighs 1650 pounds and has a capacity of 135 ampere hours at a mean rate of 30 amperes, which corresponds to a run of about 30 to 36 miles; the positive plates are of the Plante type, and the negatives of the so-called chloride types. There is only one motor, with double windings on the armature and the field, that weighs 2112 pounds and develops 3 kw. at 1500 revolutions per minute. The changes of speed are all made by means of the different couplings of the two windings, the batteries being always in series. The steering is done by means of a vertical wheel, having a handle and operating by means of a worm wheel, the reduction being as one to fifty-two, which enables the steering to be done accurately, but requires very rapid handling for short turns.

**Water-Power Plant.**—A plant which differs somewhat from the more common ones in which water-power alone is used is illustrated and described in the London "Electrical Engineer;" it supplies light to the villages of Lynton and Lynmouth. The water-power is obtained from a river enabling a fall of nearly 90 ft. to be utilized, but during the dry season the quantity of water is not sufficient to carry the peak of the load, although all the power available during the twenty-four hours, if stored, would more than suffice. To get over this difficulty without the use of accumulators, a reservoir was constructed on a hill in back of the station nearly 800 ft. high. This holds 200,000 gallons and into this the water is pumped at the station during the hours when there is power to spare. The water from this reservoir is then used in high pressure jet wheels when needed. As the high tension alternating system is used, this appears to have been a simpler solution of the problem than if the energy had been stored in accumulators, which would have required the use of converters. It accomplishes the same thing as a dam across the river would have done, if sufficient water could have been collected during the day time, but this presumably was not practical in that case.

**The Use of a Third Brush.**—Sometimes it becomes necessary to rewind a dynamo in order to give double the voltage, and if it is a shunt wound machine it is tedious and expensive to rewind the magnets. Besides this the amount of the fine wire required would increase the cost still more. A method of avoiding the necessity of rewinding the magnets is briefly referred to in the London "Electrical Engineer," it being that invented some time ago by Mr. Sayers. It consists in using an additional brush placed on the commutator about midway between the other two; this brush is made of carbon and the field magnets are connected between it and the next main brush ahead of it in the direction of the rotation; the field will therefore be excited at a voltage equal to about half that of the dynamo; that is, by the original voltage, after that of the armature has been doubled by rewinding it. Strange to say, it seems that this third brush, which is, of course, not on the neutral line or even near, does not give trouble from sparking, and is found to work quite well; as it carries only a small current, the brush need only be quite small. An interesting property which this method has is that the machine will itself have almost a level characteristic because the main brushes are moved forward as the load increases, while the third brush remains in a fixed position, thus increasing the voltage between that third brush and the next main brush.

**Paralleling Alternators.**—Some of the difficulties encountered in paralleling alternators are overcome if an artificial load can be used so that the alternator to be switched into circuit can first be loaded with a separate load which can be thrown off gradually, as it takes its share of the useful load after coupling. The objection to this, however, is that such an artificial load is costly. A very cheap method, and one which it seems might be very satisfactory, was recently described by Mr. Dettmar in a German journal, and consists simply in a magnetic brake applied to the flywheel; the power of this brake may be adjusted quite accurately by regulating the current supplied to the magnets of the brake. It is applicable, of course, only to such alternators as have a flywheel to which the brake can be applied.

**Wehnelt Interrupter.**—The foreign papers still continue to describe further researches with this very interesting apparatus. A Frenchman named Bary, in the "Comptes Rendus," shows that there are three distinct stages in the actions of that apparatus. The first takes place when there is only a weak e. m. f. and there will then be simple electrolysis. As the voltage is increased the second stage sets in, and this is what might be called the useful one, as in that stage the current is being interrupted. With a still further increase in voltage the third stage starts, and in this the platinum becomes red hot and is surrounded by a layer of vapor. When there is no inductance in the circuit the second, or useful stage, does not exist at all, as the action passes abruptly from the first to the third, the point of transition depending on the dimensions of the platinum wire and the resistances in circuit. When an induction is inserted, interruption takes place, but the limits of the voltages between which it thus operates vary with the inductance and become wider apart as the resistance increases. What seems to have been a systematic investigation of the action of this interrupter was made by Prof. Hospitalier, of which he gives the results in a recent short paper in "L'Industrie Electrique." Briefly stated, he found the following: Other things remaining the same, an increase of the self-induction diminishes the frequency of the interruptions up to a certain value, when the interruptions start, and after this a steady current passes, producing simple electrolysis of the solution. On the other hand a diminution of the self-induction decreases the frequency up to a certain value, after which the action ceases, the platinum wire becoming red hot and allowing a constant but small current to pass. An increase of the voltage increases the frequency between certain limits. An increase of the diameter or length of the small platinum wire increases the current but reduces the frequency. By properly proportioning all the various factors which enter, the frequency of the interruptions may be varied between one per second and 2000. At low frequencies the interruptions are not sharp and decided, and the sparks are shorter. He also found that if the liquid is heated the required voltage will be lower than when the solution is cold.

Under the applications of this apparatus which he suggests, is a small electric welding apparatus for the use of jewelers and clock workers, which would be connected directly to the lighting circuits of a city. He gives no description of this, but the idea presumably is to place the interrupter in the lighting circuit and in series with the primary of a stepdown transformer, the low voltage secondary current from which is used for the welder.

A noted French writer, Prof Blondel, studied the action of this interesting instrument by finding the curves of the current and voltage, and he makes the interesting analogy that the action may be compared with a hydraulic ram, which, as is well known, will pump water to a greater height than that which operates it, of course, at the expense of some water which flows through it. This, he states, explains how the original voltage of the battery is apparently increased when such an interrupter is in circuit.

**The Magnet Known 44 Centuries Ago.**—Prof. Ewing, a noted English authority in a recent lecture remarked that it was said that a Chinese navigator named Hoang Ti as long ago as 24 centuries before Christ used a magnet for navigating a fleet of ships. This presumably was the first use of the mariner's compass. The form in which he is said to have used it was that of a fragment of lodestone, which was floated so as to be free to revolve. Lodestone, it will be remembered, is a natural magnet, consisting of the natural magnetic oxides of iron. The mariner's compass of Chinese origin was first brought to Europe in the 13th century by a man named Marco Polo. Notwithstanding these early uses of the magnet, the science of magnetism will be only 300 years old next year, as it dates from the publication of Gilbert's famous book in the year 1600.

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# NOTES.

**The Annual General Meeting** of the American Institute of Electrical Engineers will be held at the Massachusetts Institute of Technology in Boston on June 26, 27 and 28.

**The Independent Telephone Trust.**—The promoters of the proposed consolidation of telephone manufacturing interests failed to perfect their organization before May 1, when the options they had obtained expired.

**Canadian Electrical Associations.** — The Maritime Electrical Association held its second annual convention in Halifax, Nova Scotia, Tuesday, April 18. The Canadian Electrical Association holds it next annual convention at Hamilton, Ontario, the 28th, 29th and 30th of June.

**An Electrically Lighted Royal Train.**—An English railway company has recently completed a train for the use of the Royal family at a cost of some $40,000. It consists of five cars, all of which are electrically lighted from one axle-driven generator, supplemented by a storage battery in the baggage department.

**Experiments with Wireless Telegraphy in Chicago.**—Mr. Arthur V. Abbott, Chief Engineer of the Chicago Telephone Company, gave an address on wireless telegraphy, illustrated by experiments, before the Y. M. C. A. Electrical Club on Friday, May 12. The results of the experiments were rendered perceptible to the whole audience by connecting the coherer circuits with incandescent lamps and electric bells to give visible and audible indications of the transmission of the waves.

**A New Building for the Franklin Institute.**—The Franklin Institute of Philadelphia is considering the erection of a fire-proof structure in which its valuable library and collection of documents and manuscripts can be kept. Like the scientist by whom it was founded and for whom it is named, the Institute has been prominent in both the scientific and practical aspects of electrical engineering and has many valuable original documents relating to this field.

**The First United States Government Cable Ship.**—A cable-laying and repair ship has been fitted out for service in the Philippine Islands by the United States Government, the ship being one captured from Spain and since used as a transport under the name of "Hooker." As reconstructed, the ship contains 3 cable tanks with a total capacity of about 700 tons of cable. The equipment also contains the usual paying-out and winding-in machinery and cable testing instruments. The ship is 333 ft. long with about 2000 tons displacement and is driven at a speed of 13 knots by a 1600 h. p. engine.

**The Combination of Copper Producers.**—The present high prices of copper are likely to continue if the plans of the recently organized Amalgamated Copper Company are carried out. The company was incorporated with a capital stock of $75,000,000, which was immediately subscribed some four or five times over at par value when the subscription lists were opened to the public. The officers include Wm. J. Rockefeller and others of Standard Oil fame. The company has taken over large interests in the Anaconda Copper Company, as well as other properties in Montana, and will, if rumors are verified, obtain control of all the Michigan copper mines and the United Verde mines in Arizona.

**The American Electrician in Japan.**—The accompanying set of characters are a reproduction of a notice in the Japanese "Electrical Friend," a monthly electrotechnical journal published in Tokyo. The translation is as follows: "The American Electrician, New York, issued monthly, at a subscription of $2.00, including postage, is devoted to American practice in electrical engineering. Electric lighting, the electric railway, the telephone, telegraph, practical operation and everything concerning electricity are ably treated in richly illustrated articles. Apply to the

American Electrician, New York.

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米国紐育市 American Electrician 社

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THE AMERICAN ELECTRICIAN IN JAPAN.

"Electrical Friend," Tokyo, which has special arrangements with the American Electrician.

**Another Combined Electrical Exhibition and Convention.**—The exhibit features of the convention of the American Street Railway Association have extended to such a point that this year their interest to the public in general will be recognized and made profitable by establishing an electrical exhibition to be open from September 25 to October 9, immediately following the convention. There has been incorporated the National Exhibit of Electrical Arts Company with an authorized capital of $50,000, to take charge of the exhibition.

**The Earnings of the Chicago-Edison Company.**—The annual statement of the Chicago-Edison Company for the fiscal year ending March 31 shows a gross income of $1,954,877, an increase of 17 per cent. over that of last year. Of this $1,214,621 was absorbed by the operating and other general expenses, leaving a net income of $740,256, of which $262,524 was paid out as interest upon the $4,808,000 of bonds and debentures outstanding and $396,072 was paid as an 8 per cent. dividend upon the outstanding capital stock.

**Removing a Large Chimney.**—An economical means of bringing down the brick of a large stack 266 feet high and 21 feet in diameter is described in "Industries in Iron." The brick was removed from one side at a heighth of about 3 feet from the ground and replaced by built-up wooden blocks, between which were packed tar, sawdust and paraffine, which were then set on fire. The chimney was thus made to fall in exactly the line marked out for it on the ground. The cost was only half of its removal by throwing the brick down and considerable material was recovered for future use.

**Alternating Waves Checked by Zinc Vapors.**—In a paper recently read before the English Institution of Electrical Engineers there were described experiments made with alternating current arcs between carbon and an alloy of zinc. In this case the current is purely unidirectional, the waves or half cycles of that polarity which would make the zinc the positive electrode being entirely suppressed. The action is the same as the phenomenon turned to practical account in this country in the construction of non-arcing lightning arresters, the vaporization of the zinc practically forming an insulating sheath.

**The Lighting of the Greater American Exposition.**—The remarkably beautiful illuminating effects obtained solely with incandescent lamps on the court of honor of the Trans-Mississippi Exposition at Omaha last year will be exceeded this year in the Greater American Exposition which is to open July 1 on the same grounds and using the same buildings. Over 15,000 new lights are being placed on the main buildings alone, to further outline their graceful proportions. The same general principle will be adhered to of obtaining a harmonious effect by uniform brilliancy, no arc lights being allowed to disturb the softer glow of the incandescent.

**Electric Traction on the Main Railroads in Italy.**—Owing to the absence of coal in Italy and the consequent extensive use of water power, the government contemplates the adoption of electric traction on the Italian railroads, which are nearly all government property, although leased to operating companies. One of the largest railway companies has recently put in service an accumulator equipment on its line between Milan and Mon-

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xa, a distance of eight miles. The cars are fitted for 100 passengers and run at a schedule speed of 25 miles per hour. They are fitted with accumulators sufficient to run for 43 miles on a level track. Other experiments are shortly to be made with the third rail systems and possibly with induction motors and high tension transmission.

---

**The Litigation on the 3-Wire Patent.**—The motion for a preliminary injunction brought by the General Electric Company against the Imperial Electric Light, Heat & Power Company of St. Louis has been denied; the opinion of the court being based on the fact that there has been no adjudication by any court of the validity of the 3-wire patent, and no such general acquiescence in the rights of the patent as to justify the injunction. This inability to obtain a preliminary injunction practically throws the use of 3-wire systems open to the public, as the patent expires within one year's time, subject, of course, to the possible collection of claims on the part of the present owners for the unexpired term of the patent in case of a final decision upholding its validity.

---

**Railway Motors to Be Manufactured in England.**—Hitherto there has been no concern engaged in the construction of railway motors in the British Isles, but a syndicate has recently been formed by Dick, Kerr & Company, the well known contractors, for the manufacture of dynamos, motors and controllers for electric railway purposes only. The designing will be entirely in the hands of the well known American engineer, Mr. Sidney H. Short, whose work was a strong element in the rapid growth of the enormous business recently handled here by the Walker Company. The English syndicate has been formed with a capital the equivalent of $1,000,000, and will build a factory in Preston, which will be equipped with apparatus a large part of which was purchased in this country on a recent visit of Mr. Short and Messrs. Geo. Flett and T. S. Turnbull of the syndicate, all of whom sailed for England on May 6th.

---

**Novel Engine Governing.**—A 1200 h. p. Willans engine which is being built for the Liverpool street railway is fitted with a combination of throttling and cut-off variation unknown on this side of the water. The governor normally controls the speed by throttling, but the engine is designed for a considerable overload capacity, owing to the fact that it is to be uesd in traction work, and the dynamo to which it is to be coupled will be capable of standing such an overload for short periods of time. If the speed continues to fall when the throttle is full open the governor opens a valve, which admits steam to a relay cylinder, which controls a linkage, lengthening the cut-off. If this is not sufficient the relay cylinder finally opens a set of by-pass valves, which allow high pressure steam to enter the low pressure cylinders, the engine working single expansion on all cylinders, instead of compound, until the overload is removed.

---

**A Curious Dam Failure.**—On the morning of April 30th a section of masonry 175 ft. long of the upper dam of the St. Anthony Falls Water Power Company of Minneapolis, Minnesota, was overturned in quite a remarkable manner, if the theories by which the accident is accounted for are true. The pond back of the dam is 300 ft. in width and during the last winter, which was extremely cold, the ice formed to a thickness of about 6 ft., clinging to the shore on one side and the dam on the other and rising and falling in the middle as the water level changed with the demands of the various mills supplied from the pond. It is supposed that when the water fell the ice would sag in the middle and crack, and these cracks would fill and freeze, forming a long inverted arch which, when the water rose again, would act like a mammoth toggle joint and exert an enormous horizontal force against the dam. The various manufacturing interests using power from this fall must depend in part on their auxiliary steam plants until the break can be mended; among these are the Minneapolis General Electric Company. The extensive plant of the Twin City Rapid Transit Company, recently described in these columns, obtains its power from another dam further down the river.

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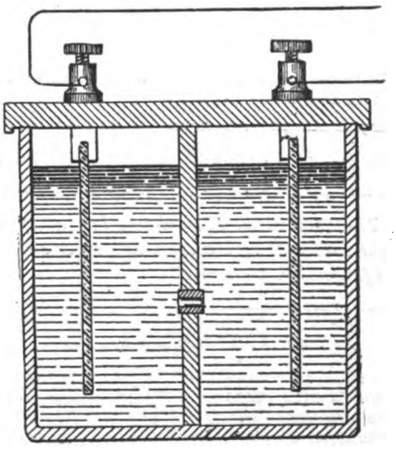
**The Classification of Electrical Freight.**—The committee of the National Electric Light Association appointed to effect some readjustment of the freight classification on electrical merchandise reports that it has received from the official classification committee of the railroad companies a reply from which the following is an extract:

"I have to advise that the subject was presented to the classification committee for consideration, but after careful deliberation the committee did not deem it expedient to recommend any change in the classification of this class of property."

It is the desire of the committee of the National Electric Light Association that all manufacturers and others interested in tariff changes have some one present at the convention to be held at Madison Square Garden, New York City, May 23-25, who will meet with the committee with the idea of taking some vigorous steps calculated to bring about a just and equitable tariff. It is apparent, and has been for some time, that ordinary appeals to the railroad organization as represented by its classification committee will prove inadequate to accomplish the desired end. An announcement will be made on the opening day of the convention of a time and place for a special meeting to be held with the committee on this particular subject, during the session of the convention, that steps may be taken other than the usual resolutions that follow a committee's report. Every central station in any large city, or any considerable user of electrical apparatus, as well as every electrical manufacturer of heavy machinery and electric lamps, should be sufficiently interested in this subject to have some one in attendance at the convention to advise with the committee in carrying out the object for which it was created.

---

**A New Liquid Interrupter.**—Mr. E. W. Caldwell of New York has communicated to the "Electrical Review" a description of a liquid interrupter, resembling that associated with the name of Wehnelt, but differing therefrom in that both the terminals of the interrupting gap are liquid. A preferred form of the apparatus is shown in the accompanying illustration, reproduced by permission of the "Electrical Review," where it will be seen that two electrodes dip into liquid in two chambers respectively, which are connected only by a small aperture at which place the interruption takes place. Another form of insulating partition con-



A LIQUID INTERRUPTER.

sists of an ordinary test tube having a small hole in its side. The communication referred to also shows photographic reproductions of the high tension spark discharges from induction coils provided with this interrupter, which resemble closely previously published photographs from high tension alternating current transformers operating at 150,000 volts or thereabouts. Mr. Chas. T. Child has also published in the same periodical an account of experiments performed with this new interrupter. Upon operating it with a current of about 6 or 7 amperes at 110 volts, the pressure rises to such a heighth across the interrupter that an incandescent lamp shunted around it is immediately blown to pieces with a sharp report. The same writer gives also the comparative effect on an induction coil of both the Wehnelt and Caldwell instruments; when the former is used the secondary discharge appears as a roaring arc across the terminals, while the latter gives a discharge with the appearance of a shower of blue sparks of great energy.

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**The Electric Light Convention.**

The twenty-second annual convention of the National Electric Light Association, which convenes in Madison Square Garden May 23d, will be chiefly notable, so far as can be determined in advance, for its combination with the electrical exhibition. Of late the exhibit features at the electric light conventions have fallen off until they have become far less elaborate than the corresponding features of some other annual meetings, such as that of the American Street Railway Association. This year the exhibits will be more extensive than ever before.

The list of papers includes two by those well-known speakers at previous meetings, and notably at the last convention, Messrs. Herbert A. Wagner and Louis A. Ferguson, although this year their subjects are not likely to excite the animated discussion which the subjects of last year did. These and other papers exhibit a notable leaning toward the rather exceptional installations of the largest cities as opposed to the average central station of the medium sized city. Undoubtedly the methods of working used in the larger metropolitan plants are more scientific and represent better engineering than do those of the smaller systems, but the latter plants are often prevented from using them by the inability of their comparatively small loads to make any returns on such expensive equipments, making their problems more perplexing than those of the large plants.

Of the eight papers announced, six, including the two mentioned above, are by men immediately engaged in central station work. One is by Prof. C. E. Robb, of Hartford, Conn., treating of the valuable experiences gained in the notable Hartford transmission plant, and the eighth is by Mr. W. R. Emmet, on the safety devices in electrical distribution, a vital subject which he is fully competent to discuss owing to his extensive experience in the Niagara and other systems handling large powers at high voltages and through many transformations.

**Arc Lights from Alternating Generators.**

In the attempt to do away with the large variety of generators which have been common in the central stations of the last decade, three general systems have been developed for supplying series arc circuits from alternating current generators simultaneously used for incandescent and motor loads. One of these consists simply in driving ordinary series arc dynamos by alternating current motors. A notable installation of this kind, constituting as it does the electrical transmission of power at 2000 volts for a distance of 20 ft., is that of the Boston Electric Light Company, a description of which will be found on other pages. This plan only in part does away with the disadvantages of the conventional arc system, which are excessive floor space, attention, losses and the general complication of many small units. To be sure, the belting and shafting is done away with, but the arc dynamo remains with all its disadvantages.

Another plan involves the use of rectifiers, which have not as yet been commercially used in this country, although one machine for 25 cycle multiphase circuits has been perfected, and may be soon on the market. There will be found on another page descriptions of English apparatus of this kind for working series arcs from 60 cycle single-phase alternators. The rectifier reduces greatly the first cost, floor space and losses of the motor generator combination.

The third method involves the use of alternating currents in the lamps themselves, the series circuits being fed through transformers designed to automatically regulate to give constant current from the constant potential primary. The first cost of such a system is lower than of either of the others, but the efficiency is some little less, owing to the lower economy of alternating current arcs, although this disadvantage is probably small in the enclosed form of lamp. In common with the rectifier it throws a considerable lagging load upon the alternating current machinery, but it differs from the rectifier in requiring practically no attention.

**Some Possible Limitations of Wireless Telegraphy.**

The remarkable series of experiments recently carried on by Signor Marconi in England have indicated that ether-wave telegraphy has possibly such a large field of usefulness that they have even occasioned no inconsiderable drop in the market quotations of the stock of telegraph and cable companies. At present so little is known about the behavior of the ether waves that it is impossible to foretell with any certainty whatever what the new system of signalling may develop, but a few of its possible limitations can be laid down.

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It is obvious that for any extended use there must be found some system of shielding any receiver from the influence of all other transmitters but the one to which it is supposed to respond. Otherwise, the use of one transmitter, with a range of—let us say—100 miles, would prevent the transmission of any other signals in a district with an area of some 30,000 square miles. To be sure the general distribution of intelligence from one central source might be made useful in press service, and it is easy to picture a central transmitter at some such point as London sending, without a single wire, general news and intelligence to all points in the British Isles where coherers are set up. It should be noted, however, that the available speed at present is rather low for such service, being given by the English publications as only 12 to 18 words per minute. If the very limited experience obtained in this country is any guide, this is due to the confusion arising from the intermittent action of the induction coil and the liability of mistaking the chattering of the coherer in time therewith for Morse dots unless the latter have a time duration considerably greater. This may be remedied by the use of higher frequencies derived from alternating currents, Wehnelt interrupters or other devices.

---

It is self-evident that there are only two general ways of limiting one receiver to the messages from its own transmitter. One is by means of reflecting, focusing or concentrating the waves and the other by syntonizing or tuning the receivers and transmitters in pairs to different frequencies. The first method depends upon the transmission of the waves in rectilinear lines like rays of light, which does not appear to hold true, the transmission being apparently more like that of waves of sound, and capable of infinite deviations from a direct course. At any rate such focusing would be impossible at any great distance owing to the curvature of the earth and the fact that the latter is an effective shield. As for syntonizing, it is probable that only a few instruments could be worked in one locality by this method, as but one or two octaves would be available owing to the influence of odd harmonics upon their fundamental, and past experience with harmonic telegraphy gives some indication of the number of different frequencies which could be isolated in one octave.

As for the distance of transmission, a wire about 180 ft. high is said to carry effective signals 16 miles, the distance varying as the square of the height. This may be increased somewhat by the use of greater power in the transmitting apparatus, but this figure gives a rough idea of the necessary height for long distance transmission.

---

**Features of English Central Station Practice Worthy of Imitation.**

To the central station engineer the study of foreign plants is second in value only to that of stations more nearly representing his own work in this country. Among the latter he finds exactly his own conditions, and the way in which others have met them as developed under the influence of the prejudices and habits of mind and of engineering peculiar to this country. The wide awake engineer, who wishes to forestall so far as possible the coming changes in electrical engineering, and thereby not only increase the economy of his plant but greatly reduce its depreciation by installing apparatus some years ahead of the times, must feel the need of watching what other nations are doing with their contemporaneous developments along lines differing from ours owing to racial characteristics, and who are likely, therefore, in some lines, to have found methods, systems or details superior to our own.

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On other pages there will be found descriptions of those features of some English central stations which strike the mind of an American observer as of interest owing to the contrasts they strike with corresponding American methods. One of the greatest of these contrasts is the extensive use of 450 volt 3-wire systems using 220 volt lamps, something quite unknown in this country. Indeed, so firmly has the idea become established that 225 volts is as high a pressure as should be allowed on interior incandescent lighting that probably no little difficulty would be encountered in establishing such a system. Two hundred and twenty volt lamps have during the last two years come into no little use in this country on 2-wire systems for two purposes, one the distribution of current over considerable areas without the losses of alternating current distributions, and the other the lighting of buildings fitted with isolated plants and with what is known as the "break-down" service on Edison mains, but it is generally considered that a sacrifice of some 15 to 20 per cent. must be made in the economy of the lamp in order to utilize a higher voltage. In other words, if the regulation is such that a 3.1 watt lamp can be used on a 110 volt system a 3.6 watt lamp must be used on the 220 volt system. This is probably the case under the existing conditions of lamp manufacture and voltage regulation in this country. In England it seems to be customary to use lamps of the same economy on the higher voltage as on the lower and to sacrifice somewhat the life of the lamp. Probably the same could not be done here, as with the poorer regulation customary in this country the high economy high voltage lamps would be burned out during the first few hours of their life.

---

One effect of the high voltage upon the lamp circuits in England has been the development of fittings of a much more substantial and highly insulating character; particularly is this true of sockets which are not of the flimsy stamped sheet brass type known here, but are of a much more rigid and substantial character.

---

**Circuit Breakers for Flat Rate Customers.**

The development of a small and cheap circuit breaker designed to open on from 5 to 25 amperes has brought up the possible application of an instrument of this class to prevent flat rate lighting consumers from imposing upon the central station by applying a load greater than that for which they are paying. The comparative accuracy and generally more dependable qualities of the breaker would allow a closer check to be obtained upon the load consumed than can possibly be had with such a crude device as a fuse. The application of such an instrument would probably please the consumer as it would enable him to re-establish his circuit without bothering with fuses or without the delay of sending word to the central station, and in this way also considerable time of the station employees would be saved. The main objection to such a course is the temptation for the consumers to change the adjustment, add weights to the armature or tie the blades of the breaker in the closed position. It might be well for circuit breaker manufacturers to design an instrument enclosed in such a way that it could not be tampered with, somewhat on the general principle of the "pop" safety valve.

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## THE DESIGN OF A SINGLE PHASE RECTIFIER.

BY J. C. BROCKSMITH.

The idea of rectifying alternating currents is not a new one, and it has already been applied to a considerable extent in English alternating current supply stations, where Ferranti rectifiers are used in connection with constant potential to constant current transformers for supplying a unidirectional current to arc lamps. Such an apparatus has a high efficiency, and it has the further advantage of occupying much less space than arc machines to do the same amount of work.

In this country the Brush and Thomson-Houston arc machines furnish familiar examples in the rectification of alternating currents, the former being virtually a two-phase generator with a rectifying or "two-part" commutator, and the latter a Y-connected three-phaser with the free ends of the Y connected to three commutator segments for producing a unidirectional current in the external circuit.

In addition to these instances there are many alternating current generators, both single-phase and polyphase, which are compounded for constant potential by means of a rectified current taken from the main winding and led through series coils on the field magnet.

The rectification of alternating currents is thus a perfectly practical operation, where the apparatus for accomplishing it has been designed with due regard to the principles involved, and to the somewhat exacting requirements of the case.

A little thought will show that no alternating e. m. f. can be rectified into a perfectly uniform direct e. m. f., although this can be approximated more closely as the number of phases is increased. Thus a single phase e.m.f. when rectified has a considerable amount of pulsation, a two phase e.m.f. will have less, while a rectified three phase current will be about as constant as is necessary for practical purposes.

While a rectified single-phase e. m. f. has this fluctuating character, it is not very objectionable, especially when working with a load having little or no self-induction, such as arc lamps or storage batteries. In fact it has been stated that a certain amount of fluctuation in the current in these classes of work is somewhat of an advantage.

The more important requisites for a rectifier are: (1.) It must always run in exact synchronism with the generator which is supplying the power. (2) It must not fall out of step easily nor be in the least disturbed by a draft of current from the direct current side. (3.) Its armature must not only maintain synchronous speed, but must also keep a constant and correct angular position within the revolution. (4.) It should preferably be self-starting and self-exciting, and (5.) It should not require constant attention nor be subject to serious sparking, or wear and tear.

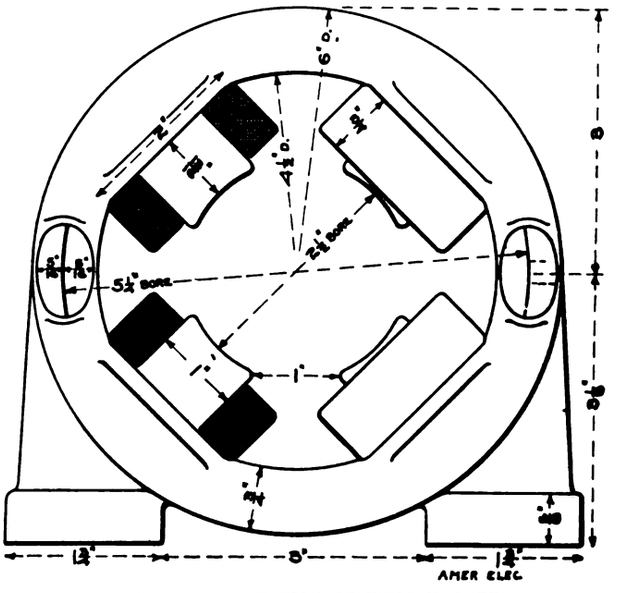



FIG. 1.—END ELEVATION OF FIELD MAGNET.

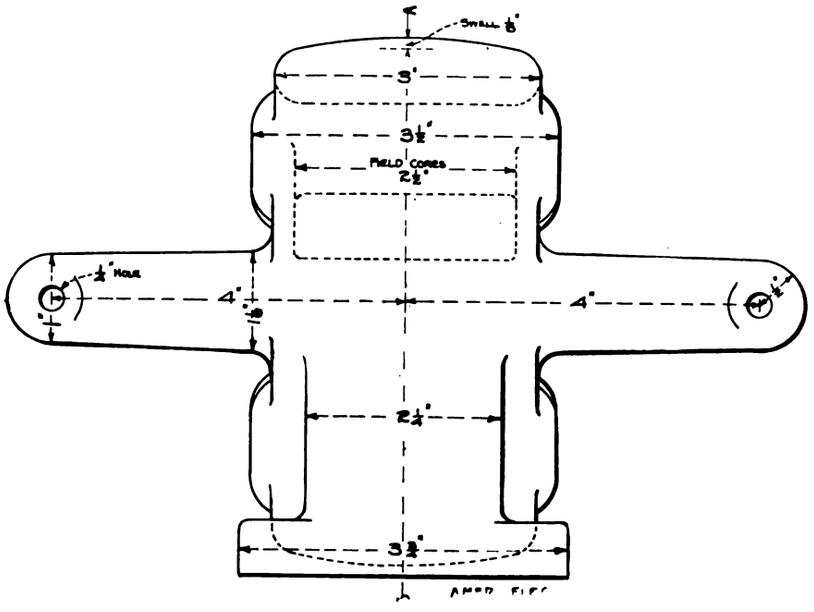



FIG. 2.—SIDE ELEVATION OF FIELD MAGNET.

The first requirement is best met by designing a regular synchronous motor to do the work of driving the commutator and collector rings. The writer has experimented with different forms of induction motors designed with a view to securing a more or less pronounced tendency to run in synchronism, and though such machines are self-starting, the tendency to remain in step is somewhat weak and a variation in the voltage of supply will throw the machine out of step and cause bad flashing at the commutator.

The second requirement is met by providing a toothed armature having one tooth per pole, and giving this a small mechanical clearance. Such an arrangement gives a strong synchronizing power.

The third requirement may be met by running the machine at a constant load, and by providing a considerable amount of inertia in the armature by means, let us say, of a flywheel on the end of the shaft. This will entirely prevent a very objectionable surging action which would otherwise occur.

When the armature is running free and no flywheel effect has been provided, there will be an oscillation to and fro all within the space of a single revolution, which will react on the current, causing this to fluctuate also; the effect then grows rapidly worse and finally throws the armature out of step. By putting a mechanical load on the machine or letting it drive the armature of another machine, the same result can be obtained as with a flywheel.

About the fourth requirement it may be said that it is not so important to have a self-starting machine when it is to be used in a laboratory and can be conveniently started by some outside means. It can easily be made self-exciting by connecting the field terminals to the direct current brushes.

Self-oiling bearings and spring brush holders will answer the fifth requirement and give a machine which will run for considerable periods of time without any attention whatever.

Let us now turn to the working drawings and see how a single-phase rectifier can be constructed.

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Fig. 1 shows an end view of the field magnet with coils in place, two of which are represented as cut away to show the shape of the poles and cores.

The circular yoke, poles and arms for supporting the bearings are cast in one piece, thus avoiding joints in the magnetic circuit, and reducing the machine work to a minimum. The pattern for the field casting should be made in two pieces, the parting being made along the line AB in Fig. 2.

The field casting is mounted on the face plate of the lathe—one of 9 ins. swing will do—and the poles are bored out to the required diameter, 2½ ins., at the same time the arms for the bearings are finished to the arc of a circle 5¼ ins. in diameter. These may, however, be filed and fitted by hand, if this is more convenient, but the method of boring is the more accurate.

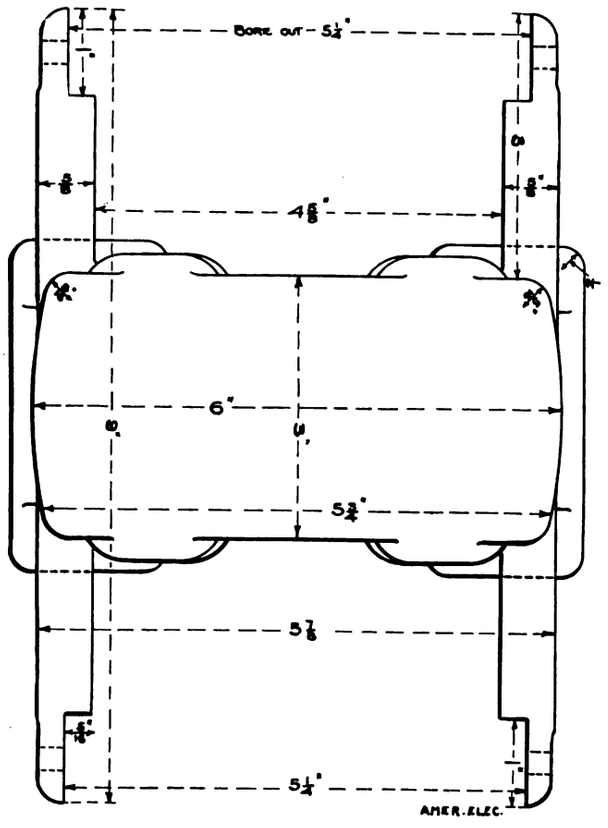



FIG. 3.—PLAN OF FIELD MAGNET.

Fig. 4 shows a section through the armature, commutator and bearings. The armature core is built up of laminated iron in the usual way, and held together by heavy washers of wrought iron threaded on the shaft at either end. A cast-iron core may be used, though it will, of course, heat up more than the laminated one.

The commutator and collector rings are turned as a solid cylinder of the required section, and it is then cut into four equal segments with a milling machine, or with a sharp hacksaw and hand power, if a milling machine is not available. The segments are then built up with mica insulation and clamped in a brass sleeve fitting the shaft.

It is well to follow the design of arc machine commutators to some extent and to allow about 1/16 in. air insulation between the segments at the top. Thus the mica insulation will not be injured if sparking occurs. Oil and copper dust should not be allowed to accumulate in the air spaces thus formed, as this would cause a severe short circuit.

Connections are made between the collector rings and commutator bars with some strips of copper about 1/32 in. thick and ⅜ in. wide, laid in the armature slots, which have been made about 1/16 in. wider than would otherwise be necessary in order to accommodate both the coils and the connection strips. The back collector ring is drilled with ⅛ in. holes at four equidistant points, two of these holes, the opposite ones, go through the ring and part way into the front ring, the other two holes are drilled only part way in. Some short pieces of copper wire, about No. 10, are soldered one into each hole, the two wires from the front ring being insulated from the other ring where they pass through it. The four wires are soldered one to each strip, and these carry the current across the armature and connect to the commutator segments.

Diametrically opposite segments of the commutator are thus connected to the same collector ring, and neighboring segments have between them the whole po-

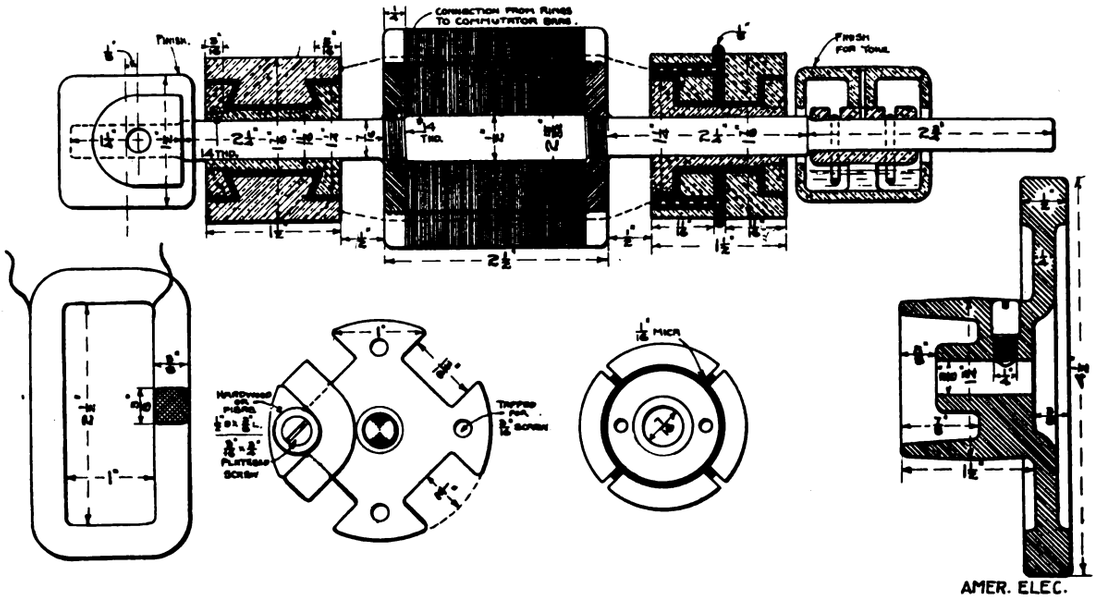



FIG. 4.—SECTION OF ARMATURE AND DETAILS OF CORE, COMMUTATOR AND PULLEY.

preferably made of copper, though brass may be used. A piece of ingot copper can be obtained and forged into a circular blank suitable for turning up into rings and a commutator. The commutator is

tential difference of the alternating circuit.

It is better not to connect the copper strips permanently to the commutator until the builder has decided where he

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wishes to place the brushes; the commutator may then be twisted around on the shaft to the correct position and the connections made permanently. The brushes may be placed wherever they will be most convenient, the only restriction being that they must be 90° apart and must pass from one segment to the next at the same instant that an armature tooth is exactly under a pole.

A detail in Fig. 4 shows the method of placing the armature coils upon the core. The coils are wound on a form, and, after being taped, are slipped over the top of a tooth. The slack is then taken up by bending the ends down in a semi-circular shape and fastening them in this position by screws which carry small fibre or hardwood bushings.

In addition to this the armature should be banded at one or two points with No. 28 brass or German silver wire, small notches having been turned in the core to receive the bands and allow them to come flush with the surface of the core.

With an iron-clad armature like this, the clearance need not be more than from 1/64 in. to 1/32 in.; just how much it will be depends somewhat on the builder's skill; 1/64 in. clearance has been indicated on the drawings, and with care taken in adjustment it should not be difficult to obtain this figure.

Fig. 5 shows the bearing, brush yoke and brush holders. The bearings, while not so simple in construction as some other designs, have proven very satisfactory. The rings carry up a plentiful supply of oil, and what runs out at the end returns to the well and does not fly off outside the bearing and spatter the surroundings with grease spots.

In finishing the bearings the cap is first fitted and fastened by two machine screws. The bearing is then placed in the chuck and bored out to a diameter of ⅝ in. clear through. At the same time the ends are turned off 5¼ ins. in diameter to fit the arms on the field casting, and the outside of the boss is turned off 1½ in. diameter where it is to receive the brush yoke. The sleeve which forms the bearing proper is turned a tight fit for the central part of the box, then when the cap is screwed down it will be held firmly in place. The grooves for oil rings can be cut in the sleeve conveniently by mounting it eccentrically in the chuck and using a thin cutoff tool.

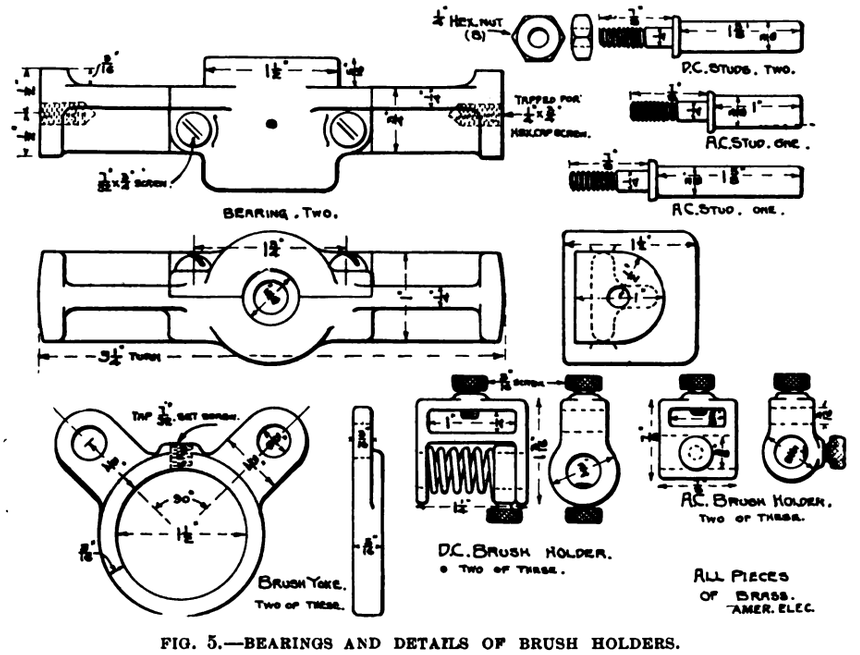



FIG. 5.—BEARINGS AND DETAILS OF BRUSH HOLDERS.

The brush yoke is shown with two arms 90° apart. Another pair of arms and brushes might be added if it is desired to have more current carrying capacity.

The direct current brushes had better be larger than the alternating current brushes, and the holders should have spring tension, unless a very springy brush is used. Copper brushes are better for this purpose than carbon, as they make better contact and cause less sparking.

Fig. 6 shows the field and armature coils and the forms upon which they are wound. The former is best made of hard wood, and consists of a block and two flanges, all held together by two wood screws and having a ½ in. hole through the center for placing on a mandril in the lathe. The block should be made a trifle larger than the pole over which the finished coil is intended to go, and it should be given a slight taper of about 1/16 in., so that it can be readily slipped out of the finished coil.

Before beginning the winding a short piece of tape is laid in the long sides of the former, with the ends left sticking out. When the form is wound full these pieces of tape are tied tightly over the coil, and will hold it in shape while the former is taken apart and the coil is receiving its wrapping of tape. After being shellacked and dried, the coil is placed on the poles and hard wood wedges driven in between coil and pole, thus holding it securely in place.

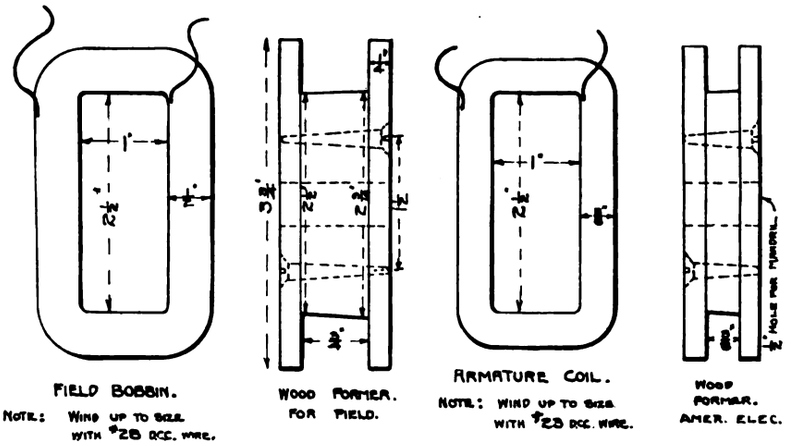



FIG. 6.—ARMATURE AND FIELD COILS AND FORMERS

The same form may be made to serve for both field and armature coils, if the field coils are wound first, and then the block reduced in thickness from ¾ in. to ⅝ in., the armature coils having the same inside dimensions as the field coils, but being only half as thick.

The fields are wound with No. 28 double cotton covered wire and the armature with No. 23. If the coils are wound to the specified dimensions they will have nearly enough the required number of turns.

Fig. 7 shows a diagram of connections and some e. m. f. curves. For 100 volts the field and armature coils are connected four in series, as shown. For 50 volts the coils may be connected two in series and the twos in multiple. The armature terminals are tapped onto the collector rings, or what amounts to the same thing, placed across any two successive commutator segments.

The connections on both armature and field should be such as to produce alternate north and south polarity all the way round. If all the coils have been wound in the same direction and placed on the poles the same way, connect beginning to beginning and ending to ending, and the polarity will be right.

This being a four-pole machine it will run 1,800 r. p. m. on a 60-cycle circuit, and on a 125-cycle circuit it will have to make 3,750 r. p. m. This it can easily do if the armature is well balanced as it should be.

Since the strength of the field has a con-

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siderable effect on the behavior of a synchronous motor, it is best to have an adjustable resistance in the field circuit of this machine, so that the field can be adjusted until the minimum armature current is obtained.

Referring now to the curves in Fig. 7, it is clear that if the rectifier is running in synchronism and the angular position of the brushes is correct, the brushes will pass from segment to segment at the instant when the e. m. f. curve reaches its zero value at the points, a, a, a, etc. As the brushes in passing from segment to segment overlap two segments for a brief interval, they form a dead short circuit on the alternating current mains during the interval. This will not, however, result in any damage if the e. m. f. becomes zero at the same instant. If, however, the brushes had been incorrectly placed and commutation occurred at the points b, b, b, etc., an e. m. f. of value equal to the ordinate at b would be short circuited four times in a revolution, and serious sparking would result.

This state of affairs is easily remedied by shifting the brushes, which corresponds to changing the angular position of the point of commutation until a position such as a a is reached, when all sparking will disappear.

If the armature falls out of step, or if it is thrown into circuit before complete synchronism is reached, a short circuit travels over every portion of the e. m. f. wave, at a slow rate equal to the difference between synchronous speed and the actual speed at that instant, the result being a magnificent display of fireworks and probably a fuse blown.

To obviate this latter difficulty a resistance or choking coil should be placed in series with the alternating current end at the moment of starting, and cut out when it is seen that the machine has settled down to steady running. Such a resistance will not have any appreciable effect on the small current drawn by the armature and field windings, but should be of such a value as to limit the current to about 10 amperes, should a short circuit occur.

The ordinary method of a synchronizing lamp is not easily applicable here on account of the small size of the machine; and, moreover, a little practice will enable the operator to judge by ear the proper instant for closing the circuit.

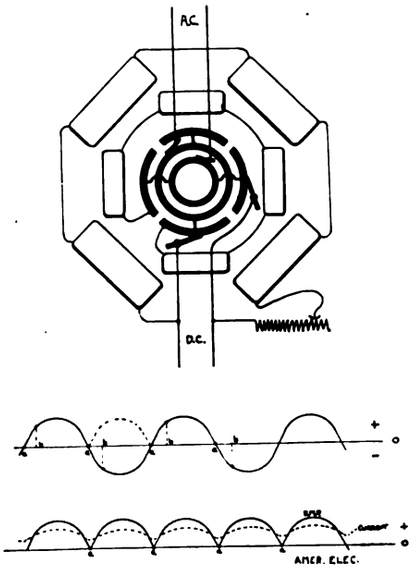
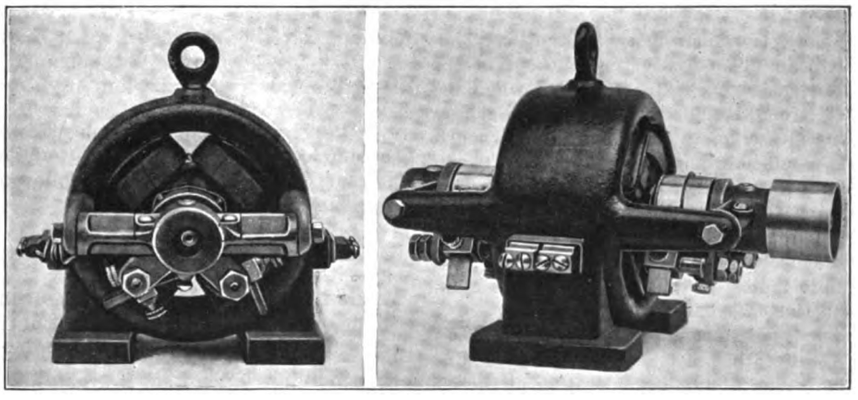



FIG. 7.—DIAGRAM OF CONNECTIONS AND E. M. F. CURVES.

Thus by making slight changes in the connections, as already pointed out, this machine may be used as a rectifier on single-phase circuits of 50 or 100 volts and 60 or 125 cycles. The amount of rectified current which may be drawn is not limited in any way by the horse power capacity, but will generally be limited only by the capacity of the transformer which is supplying the current. Thus from 50 to 100 amperes may be drawn, depending somewhat on the nature of the load into which the rectifier is feeding current.



FIGS. 8 AND 9.—TWO VIEWS OF A RECTIFIER.

The machine may also be used as a self-exciting synchronous motor, developing from 1/10 to ⅛ h. p., according to the strength of field; and finally it may be driven by belt as a self-exciting alternator, supplying either an alternating current or a rectified direct current, or both, up to about 100 watts output.

Figs. 8 and 9 are reproduced from photographs illustrating a rectifier built from these designs.

## AMERICAN TELEPHONE PRACTICE.

### SELF-INDUCTION AND CAPACITY.

BY KEMPSTER B. MILLER.

Every insulated conductor is capable of receiving a certain charge when subjected to an electromotive force; for instance, if a metallic plate insulated from all surrounding bodies is connected to one terminal of a battery the other terminal of which is grounded, a certain amount of electricity will flow into the plate until its potential is raised to that of the battery terminal. The plate is then said to be charged, and the amount of electricity held by it determines its capacity. The charge of electricity on the plate will be considered positive or negative, according to whether the positive or negative terminal of the battery, or other charging source, was connected with it.

It is well known that no charge exists by itself—there is always an equal and opposite charge induced by it upon neighboring bodies. It is also well known that like charges repel each other, while unlike charges attract; that if an uncharged body be brought near a charged body an equal and opposite charge will be induced on the side of the uncharged body which is toward the charged body, and that similarly a charge on the same sign as that on the charged body will be induced on the opposite side of the uncharged body. If now the body which was originally uncharged is connected with the ground, this latter charge, that is, the one of the same sign as the original charge, will be driven to the ground, while the charge of opposite sign will still be attracted by the charge on the first body. The second body will therefore be charged, although it has not been in contact with the first. The action between charges of electricity taking place through an insulating medium is called electrostatic induction. It is found that where two conductors are placed side by side, but insulated from each other, the capacity of each will be greater than if the other were not present. For the purpose of holding charges in this manner the well-known Leyden jars have long been in use. They are usually made by coating a glass jar inside and out with a layer of tin-foil to within a few inches of the top. The outer coating is usually connected with the ground, while the inner coating is connected with a metallic rod approaching it through the mouth of the jar. If the innner coating is connected with a source of electromotive force, a current lasting but an instant will flow into the coating, producing a charge. This charge, which we will say is positive, will attract a nearly equal negative charge to the outer coating, repelling an equal positive charge to the earth, as already described. The amount of charge which the inner coating will receive under these circumstances is very much greater than if the outer coating were not present, and the capacity of the inner coating is therefore

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much higher than before. A device, such as the Leyden jar, is called a condenser.

The capacity of a condenser is increased as the area of the conducting surface is increased; is increased as the distance between the conductors is diminished, and may be increased or diminished by using different kinds of insulating material between the conductors. The medium separating the conductors is called the dielectric and, as stated above, upon it depends to the greater extent the efficiency of a condenser. Several condensers built exactly alike so far as size of plates and the distance between them is concerned, and using different materials for dielectrics, will be found to have different capacities. This difference is due to a peculiar property possessed to different degrees by different dielectrics and called specific inductive capacity.

The specific inductive capacity of a dielectric is a measure of that quality which enables the dielectric to hold a charge between two conductors, as in a condenser. The specific inductive capacity of air is taken as a standard and is for convenience considered as unity; it is lower than that of any other known substance excepting, perhaps, hydrogen. If two condensers having plates of equal size and distance apart are constructed with dielectrics respectively of air and guttapercha, it will be found that the condenser having the dielectric of guttapercha will receive a charge nearly 2½ times as great as the condenser having the dielectric of air. The actual ration between the two is 2.462, and for this reasonu the specific inductive capacity of guttapercha is said to be 2.462. The following table gives the specific inductive capavities of some of the more important insulators:

| | |
|---|---|
| Air | 1.00 |
| Glass | 3.013 |
| Shellac | 2.74 |
| Sulphur | 2.580 |
| Guttapercha | 2.462 |
| Ebonite | 2.284 |
| India Rubber | 2.220 |
| Paraffin | 1.994 |
| Carbonic Acid | 1.00036 |
| Hydrogen | 0.99967 |

It is probable that very rapidly varying electro motive forces, such as are dealt with in telephones, the specific inductive capacities of the various substances would be higher in comparison with air than those indicated by this table.

Specific inductive capacity is a very important consideration in the construction of cables for telephone purposes. In the construction of these cables it is desirable, as will be shown later, to reduce the capacity of the wires of the cable to as great an extent as possible, and in order to do this the dielectric is, in the best forms of cables, made of dry air to as great an extent as possible. On the other hand, in the construction of condensers it is desired that the capacity may be as great as possible for a given area of plates and therefore some material other than air is used. Paper saturated with paraffin is perhaps the most commonly used, paraffin having about twice as great a specific inductive capacity as air, and moreover lends itself readily to the purposes of insulation. To sum up, the capacity of a condenser varies in direct proportion as the area of its plates, inversely as the square of the distance betwen the plates, and directly as the specific inductive capacity of the dielectric.

The effect of a condenser bridged across a circuit carrying an alternating current is to absorb a portion of the current as the electromotive force at its terminals increases, and as the electromotive force decreases, to give this current back to the line. Consider such a circuit when the electromotive force active in driving current through it begins to rise. Electromotive force at the condenser terminals will also rise, and current will therefore flow into the condenser. The strength of this current will depend directly upon the rate at which the potential at the terminals of the condenser is changing. When the electromotive force acting in the circuit reaches a maximum, the potential at the condenser terminals will also be a maximum and will for an instant cease to change. At this point the condenser is fully charged, but as the electromotive force of the line is not changing no more current flows into the condenser; in other words, the condenser current is zero. As the electromotive force in the line decreases, current will flow out of the condenser and into the line, because the condenser is not capable of holding so much charge at the lower potential. The flow of current out of the condenser reaches a maximum when the electromotive force in the line is changing most rapidly, and this occurs when it is passing through zero. From this it will be seen that the condenser current is zero when the electromotive force in the line is a maximum, and is a maximum when the electromotive force in the line is zero. This indicates, as in the case of self-induction, a phase difference of 90° or a quarter of a cycle. It is not so easy to say whether this phase difference is lagging or leading, but a consideration of the direction of flow of current throughout the cycle will throw some light upon the subject.

At the instant when the current flowing in the line (which is in exact phase with the active electromotive force in the line*), is positive and at a maximum, the condenser current will be zero. As the active electromotive force decreases toward zero the condenser surrent increases, but in a different direction—negative—because current is now flowing out of the condenser back to the line. As the active electromotive force reaches zero the condenser current is at its maximum negative value, and as the active electromotive force reaches its maximum negative value the condenser current reaches zero. During the next half cycle the condenser current increases to a positive maximum and decreases to zero, while the active electromotive force passes from a negative maximum to a positive maximum. In other words, while the active electromotive force and therefore the line current with which it is in phase decrease from a positive maximum value to a negative maximum value the condenser current is negative, and while the active electromotive force increases from its negative to its positive maximum value the condenser current is positive. The condenser current therefore reaches its zero value, while decreasing, 90° in advance of the same value of the active electromotive force; its maximum negative value, 90° in advance of the maximum negative value of the active electromotive force; and upon investigation it will be found that every value of the condenser current occurs 90° in advance of the corresponding value of the actual line current. The electromotive force which is in phase with the condenser current is called the condenser electromotive force and is 90° in advance of the electromotive force which is active in driving current through the line. This latter electromotive force, which, as we have said, is in phase with the current flowing in the line, is the resultant of the impressed electromotive force, and the condenser electromotive force, and therefore leads the impressed electromotive force by a certain angular distance.

The current equation for a circuit containing resistance and capacity is, as before,

$$\text{Current} = \frac{\text{Electromotive Force}}{\text{Impedance}}$$

In this case the impedance depends on the ohmic resistance of the circuit and on its capacity, and is equal to the following expression:

$$\sqrt{R^2 + \frac{1}{4\ ^2f^2c^2}}$$

Where f is the frequency, as before, R the ohmic resistance, and c the capacity of the condenser in farads. From this the current equation becomes

$$C = \frac{E}{\sqrt{R^2 + \frac{1}{4\pi\ ^2f^2c^2}}}$$

The denominator is the apparent resistance, depending upon the ohmic resistance of the circuit, the capacity and the frequency of alternations. An inspection of this equation will show that as the frequency f is increased the impedance or apparent resistance becomes smaller, and this acounts for the fact that a condenser will readily transmit rapidly fluctuating currents, such as voice currents. Evidently the effect of increasing f reduces the second member in the denominator of the equation, and if sufficiently great, this may be neglected, and the equation becomes simply

$$C = \frac{E}{R}$$

Again, increasing the capacity of the condenser also increases the effective current by reducing the impedance.

* The active electromotive force is the resultant of the impressed electromotive force and the condenser electromotive force, and is in phase with the current actually flowing in the line.

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Every telephone line possesses electrostatic capacity, and may be considered in the light of a condenser. In the case of a grounded circuit the line wire takes the part of one plate of the condenser, while the ground and other neighboring conductors act as the other plate. In metallic circuits the one side of the line acts by electrostatic induction upon the other, and the two together, upon the ground and neighboring conductors. The capacity of a line, however, differs from that of a condenser in that it is distributed throughout the entire length of a line, while a condenser connected with a line would have all of its capacity at a single point. Capacity, such as that of a line, is termed distributed capacity in order to distinguish it from that possessed by a condenser, which may be termed local capacity. The effect of distributed capacity upon telephone currents may be more readily grasped by imagining a large number of condensers bridged across the two sides of a metallic circuit at frequent intervals. When the electromotive force impressed upon one end of the line increases, a current flows from the source over the line wire and into the condensers, charging them all according to the difference of potential across their terminals.

The difference of potential across the terminals of all the condensers will not be the same, because there is a certain drop, due to the ohmic resistance of the line wire. If the current flows in that direction long enough to charge all of the condensers on the line then a current will reach the distant end of the line, and if it continues in that direction, will attain its full value, in accordance with Ohm's law. It must be remembered, however, that each condenser is capable of taking a certain charge, and in order to receive this charge a certain quantity of electricity must flow over the line wire.

The quantity of electricity which flows through a circuit depends upon the strength of the current and upon the time it is allowed to flow. If the time is insufficient it will be impossible for enough current to flow through the circuit to charge the condensers up to the potential of the source, and therefore the current at the distant end of the line will not reach its maximum value, and in fact may not rise practically above zero. If, therefore, the electromotive force of the source is reversed before sufficient current has time to pass through the line to charge all of the condensers, the current will not reach its full value at the distant end of the line.

It may begin to build up in the opposite direction, and again be stopped on account of the insufficient time to reach its proper value in that direction. The time in which the current in such a circuit will reach a definite portion of its maximum value at the distant end of the line is called the time constant, and if the time represented by one alternation of the electromotive force is smaller than the time constant, the current will not reach that value at the distant end of the circuit, and the transmission will be correspondingly impaired.

The reduction in the actual volume of current transmitted by the effects of distributed capacity is, however, of less importance than the distortion of the wave form. The higher frequencies of current waves corresponding to the higher overtones are absorbed by the condensers far more readily than the lower frequencies, and therefore the waves corresponding to the higher over-tones are reduced to a much greater extent at the distant end of the line than those corresponding to the fundamental and the lower over-tones. This weeds out the upper harmonics, thus tending to destroy the clearness. Capacity, however, acts in still another way to alter the form of the wave. The angle of advance for the higher frequencies is greater than that for the lower, and therefore the waves of different frequencies are shifted with respect to their phase relation, thus greatly altering the wave form.

It has been shown that the electromotive force of self-induction lags 90° behind the active electromotive force, while the electromotive force due to capacity is 90° in advance of the active electromotive force. It is not difficult to conceive, therefore, that by properly proportioning the self-induction and capacity of a circuit the electromotive force of self-induction may be made to neutralize the electromotive force of capacity, and this result is readily obtained in experimental work.

In this case, even though self-induction and capacity may be present in a circuit to a large degree, the current flowing in the circuit is in exact phase with the impressed electromotive force, and its value is in strict accordance with the ordinary expression of Ohm's law. Unfortunately, however, for long-distance telephony such a balancing of self-induction against capacity can be obtained only for one particular frequency at a time. To thus tune a circuit for one particular frequency would render that circuit capable of transmitting efficiently one particular frequency of vibration, while the requirements of telephony are that all frequencies within the range of the human voice shall be transmitted with equal facility. Again, and unfortunately, it has been found impossible to neutralize distributed capacity with anything but distributed self-induction, and this has not yet been accomplished in practice.

As for trans-oceanic telephony, the high static capacity of the cable has so far proven an insurmountable obstacle. It is impossible to conceive a transmitter capable of forcing such rapid undulations through our present form of cables. Clearly then the solution lies in the betterment of cables, or the substitution of some other transmission medium, rather than the improvement of the instruments themselves.

There can be little doubt that trans-oceanic telephony will finally be accomplished, but the indications are that our knowledge at the present time is not sufficient to cope with the problem.

## STEAM AND WATER VALVES.

### CHECKS.

Probably James Watt needed a check valve so badly the first time he got up steam in a boiler that something in that line was invented off-hand upon the spot, a modification of a pump valve probably serving for the purpose until a more elaborate form of construction was designed.

Probably the ball form of check valve is one of the earliest forms of that fitting, but the cup valve was a standard form for many years until the swing valve was invented and perfected. Fig. 1



FIG. 1.—CUP VALVE.

shows a form of cup check valve as made by the Crane Company. The disc is attached to a stem, which plays up and down in the bonnet which forms a guide therefor. The stem, though turned cylindrical, is cast with four ribs at right angles to each other, as indicated in the engraving, whereby the passing fluid can flow to and from the bonnet cavity as the check rises and falls.

The disc seats squarely upon the metallic seat of the valve, and by unscrewing the bonnet both it and the valve disc may be lifted out for renewal or repair. Defacing the seat or disc of this valve must be cured by regrinding the seat, although a new disc can be slipped in in a minute or two.

Fig. 2 shows a valve in which it is unnecessary to replace the disc when worn. It is a Lunkenheimer valve and is made regrinding. The stem is a solid cylinder and the top thereof is slotted to receive a screwdriver, whereby the disc may be rotated and ground to a fit in the ordinary manner. This valve has a conical seat, but there is a sort of plunger underneath the disc which enters the opening in the seat, so that but little fluid can be forced past the seat until the disc has risen a considerable distance, thereby protecting it from the cutting action of dust and grit.

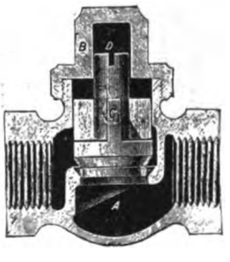


FIG. 2.—REGRINDING CHECK.

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Considerable trouble has always been met with in check valve practice by the binding or sticking of the disc and its guiding stem. This is particularly the case when used with dirty water, the sediment catching between stem and bonnet, and in many cases preventing the closing of the valve, much to the annoyance of the engineer, and in some instances becoming a source of great danger.

A form of construction adopted by some valve manufacturers to obviate this difficulty is to use a ball-shaped disc. In fact, a ball made as nearly spherical as possible is the only loose part in this form of check, as shown in Figs. 3 and 4, the former illustrating a Lunkenheimer check valve, the latter a production of the Haydensville Manufacturing Com-

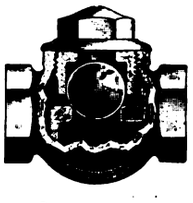


FIG. 3.—BALL CHECK.

pany. There is great similarity of construction between the two valves shown, and both are made for medium pressure, say 150 to 200 pounds to the square inch. It will be noted that there is a considerable difference in lift possible to the discs of the two valves shown. In all valves of this class the lift should be sufficient to give ample opening to the water passage, but it should be no greater than this. When either a ball or a disc check valve has excessive rise, there sometimes ensues such a hammering or pounding of the disc or ball upon the seat that both are quickly worn out. Some swing checks are ruined by this cause,

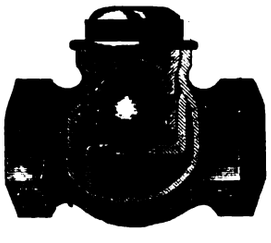


FIG. 4.—BALL CHECK.

and in certain cases where checks wear out very rapidly they may be made to last much longer by putting in a pin or a lug, which will lessen the rise of ball, disc or swing clack. But this must not be done to an extent which will reduce the flow of water through the valve, or increase the resistance to flow through the valve to any appreciable extent. If a change of this kind is contemplated, put an indicator in the pipe close to and in front of the valve, connect the instrument with the pump piston or plunger and take several cards. Then the same thing being done after limiting the rise of the valve, it is possible to ascertain if the flow has been interfered with.

In some check valves there is introduced a form of adjustable stop whereby any desired amount of lift may be given to the clack. Fig. 5 shows such a stop

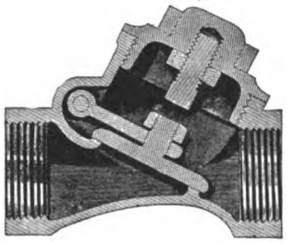


FIG. 5.—THE VAN WEIS SWING CHECK.

motion, which in this case consists of a set screw and lock-nut attached to the inner side of the bonnet. This valve is also made by the Haydensville Manufacturing Company, and is usually known as the "Van Weis" swing check. It will be noticed that the seat lies at a very flat angle with the axis of the valve, so much so that the use of this valve in a vertical line of pipe would not be satisfactory without the stop above alluded to, which prevents the swing or clack from falling back past the center of the pivot and

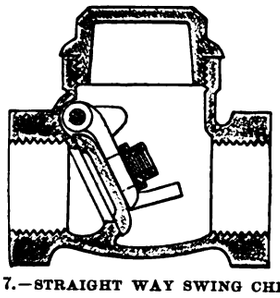


FIG. 7.—STRAIGHT WAY SWING CHECK.

thereby remaining open. Sand cannot very well find a lodgment in this valve, as the body of the valve curves up and inward at the bottom, thereby providing a form which causes the flow of water to wash the seat clean, instead of inducing a deposit, as might be the case if a hollow or a depression existed at that point.

Fig. 6 shows another form of check valve which has the same anti-sand collecting form at the bottom of the shell. There is no adjustable stop in this valve, but the shell is so designed that the clack strikes the upper portion of the valve body before it can get past the center. In

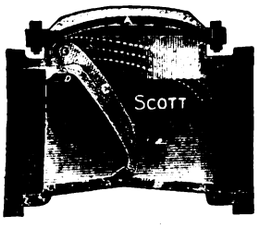



FIG. 6.—SCOTT CHECK.

this valve, which is made by the Roe Stephens Manufacturing Company, the swing makes a much greater angle with the axis of the valve than in Fig. 5. In fact, this valve is first-class for work in vertical pipes, as well as for horizontal use. The clack is made all in one piece, but in the larger sizes (above 14-inch) it is made in two pieces and there is a hole in the swing disc upon which another and a smaller swing clack is mounted, thus forming a duplex valve and obtaining a great area of opening with the least possible rise. In this form of valve the hinge of the clack is made to fit tightly in a recess in the body of the valve, so that no dirt can get in to bind and prevent the free movement of the swing.

Fig. 7 shows a form of straightway swing check valve wherein the clack stands at a still greater angle with the valve axis. The disc can swing up into a



FIG. 8.—STANDARD SWING CHECK.

recess, into which a plug is screwed instead of the usual bonnet. To prevent the swing from getting past the center when used on a vertical pipe lugs are cast upon the swing as depicted in the illustration.

This valve is a production of the Kennedy Valve Manufacturing Company and the disc is made in two pieces, the lower part being easily removeable for renewal or repair. In fact, the swinging gate revolves and is self-adjusting.

Still another check valve, and one in which the clack hangs at an even greater angle, is shown by Fig. 8. This the Crane Company calls its "Standard" swing

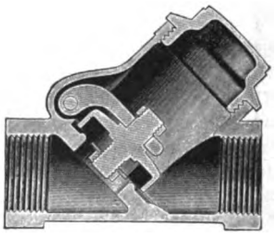


FIG. 9.—SELF-ADJUSTING SWING CHECK.

check, and it gives a straightway opening as large as the internal diameter of the pipe.

Fig. 9 shows a form of self-adjusting swing check made by the Jenkins Company, in which the regular Jenkins packing is used in connection with a loose connection between swing and disc.

There is ample room in the upper portion of the valve, which has a screwed in plug, instead of a bonnet. The clack has its motion limited, as it strikes against a side of the valve after it has risen sufficiently to give the required area of opening.

A peculiarity of this valve is that the seat is placed at an angle of 45 degrees,

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thus making the valve exactly as efficient in either vertical or horizontal piping. The disc can be quickly and easily removed and a new one inserted in case of injury by sand or gravel. It will be noted by a close inspection of the engraving that the seat is counter-sunk a trifle —not enough to catch dirt, but enough to prevent sand and water from cutting, or rather enough to prevent their impinging upon the seat surface when flowing across it.

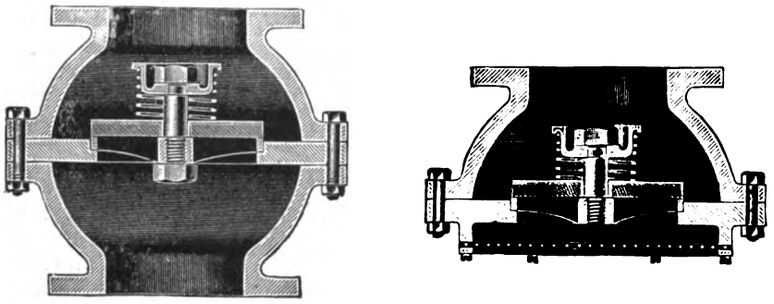


FIG. 10.—CHECK AND FOOT VALVE.

A peculiar form of check valve is frequently used at the bottom of a vertical pipe or line of piping. Then such a valve is called a foot valve, as illustrated in Fig. 10, which shows one of each kind. Really there is no difference in these valves as far as the seat and disc is concerned, both being exactly alike. In the foot valve the lower part of the body is cut off and a strainer screwed on. That is all the difference there is between them as made by the Kennedy Valve Manufacturing Company. In this class of valves the total area of valve opening should exceed that of the pipe by at least 10 per cent., and in the larger sizes the required area is obtained by placing a number of independent checks in the same case or casting. This should be done for sizes about 8 inches in diameter. The seats are removable, and are made in the form of spiders, with radial arms and a central hub, from which springs the arbor upon which the disc and spring are pivoted.

Quite a number of what may be called "freak checks" have been devised from time to time to meet certain engineering demands, and while some are valuable alone as freaks, others have proved their worth and in time will become standard articles. Fig. 11 shows a form of valve manufactured by L. Schutte and Company, in which there is a balanced horizontal check valve, in which the inclined suspension bar, shown projecting to the left directly under the stem, has a tendency to open the valve, while the bar at the right tends to keep the valve closed. The small counterweight acts when the valve is used. The stem and hand wheel is so arranged that the check may be used at will as a stop valve for fluids passing in one direction.

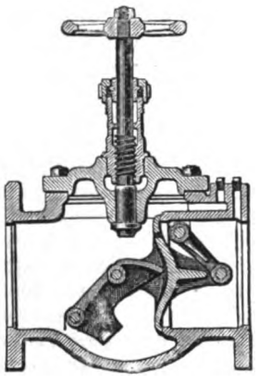


FIG. 11.—DUPLEX CHECK.

Another form of duplex valve is illustrated by Fig. 12, and is made by the Crosby Manufacturing Company. It consists of two checks contained in a single shell. The arrangement is such that if one of the swings should get out of order at any time the other valve in the shell can be thrown into service instantly by applying a wrench to a projection from one end of the shell and giving it a half-turn. This throws the defective swing out and the reserve one into line. At the same time it brings the injured swing under a hole closed with a screw plug, which may be removed at will, and the damaged check removed or repaired.

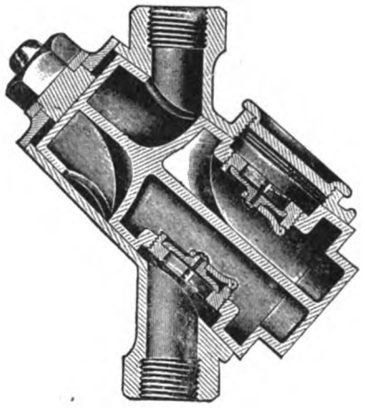


FIG. 12.—CHECK AND STOP.

If, instead of a half-turn, the shell be rotated only one-quarter of a revolution, both swing checks are put out of service and the fitting becomes a stop valve to all intents and purposes.

The trouble engineers meet with in using check valves usually consists in said valves sticking—sometimes open and at other times shut. A method of preventing the former trouble or, at least of overcoming it, has already been provided for in the valves illustrated above, and a valve with means for forcing the disc off its seat at any time is the subject of Fig. 13. Here the valve is

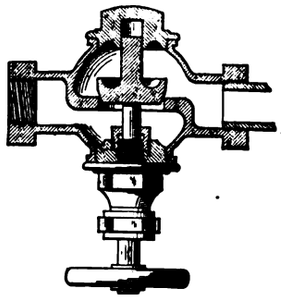


FIG. 13.—TINLEY'S CHECK.

of the disc and stem types shown at the beginning of this article. It is devised by James F. Tinley, and is particularly desirable for feeding several boilers in parallel from the same feed main. Then, if one of the checks stick, it may be quickly opened by means of the stem and hand-wheel shown in the engraving. A check nut in the bushing limits the vertical movement of the stem to a very small fraction of an inch, so at no time is the check held open thereby to any great extent.

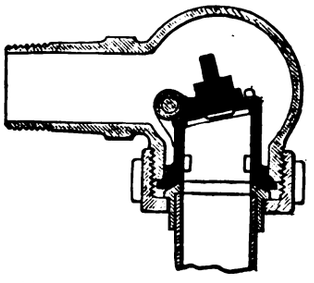


FIG. 14.—UNIVERSAL BOILER CHECK.

Another "freak" check, and one called by the manufacturers, H. Belfield & Co., a "Universal Boiler Check Valve," is shown by Fig. 14. This valve can be placed in any position, either vertical or horizontal and the seat and disc may be easily removed for repairs or cleaning. It is claimed by the makers of this valve that the usual wear of checks is due to a whirling motion given to the seat by the current of water, and by introducing means to prevent such motion the valves wear much longer.

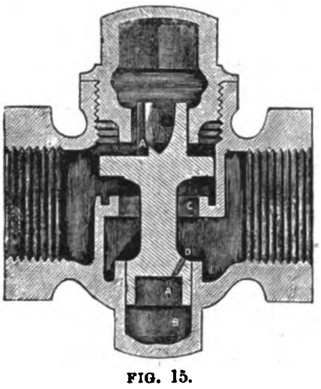


FIG. 15.

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A form of noiseless water cushion check valve, as made by the Roe Stephens Manufacturing Company, is illustrated by Fig. 15. It is known as Florence's valve, and is made with a dash-pot and piston to work in same so as to form a cushion on water or fluid, with a small outlet to let the water in on the rising or lifting of valve, and to let a portion of the water out on the downward or drop motion of same, so that sufficient liquid remains in dash pot to form a cushion, so valve will not strike heavy on seat; the small opening prevents it from striking at top on lift of valve by the suction of water under piston in dash pot.

## INTERIOR WIRING.

BY CHARLES E. KNOX.

FEEDERS AND MAINS.

In this number the method of installing feeders and mains, known as "concealed work," will be considered.

The term "concealed," as here used, signifies that the wire or conductor is covered and protected in a conduit or pipe, and does not refer to the conduit itself, which may or may not be exposed to view.

The conductor and the conduit first require a brief consideration.

The wire used in this class of work should be insulated with the highest grade of rubber. "The best is none too good," and nowhere does this apply more truthfully and exactly than to rubber used for the covering of wires. It has become almost proverbial that the principal constituents of the rubber used on the majority of the different makes of wire, instead of being caoutchouc, are erstwhile rubber overshoes, rubber coats, etc., and to this list must now be added discarded bicycle tires. "Cast thy bread upon the waters; for thou shalt find it after many days." It may be that the very wire which carries the current for lighting your house is covered with rubber formed from the tires of your old '96 wheel and your last year's overshoes. Be assured that this is entirely within the range of possibility if the rubber on the wire is not carefully examined and tested. The insulation should, in my opinion, be placed on the wire in two layers, a thin inner layer or core and a thicker outer layer. Over this there should be a protective braid or tape covering. Braid has the advantage of being flexible, but it is somewhat bulky and absorbs moisture. Tape, on the other hand, is not bulky and does not absorb moisture to such a great extent, but it is apt to break when the wire is bent sharply. So much for the covering of the wire.

As to the wire itself, for feeders or mains the wire should be composed of strands of small wire twisted or formed into one conductor of the required size. Of course, where the feeder or main wire is smaller than No. 6 B. & S. gauge this absolutely essential, but for the larger conductors it is indispensable. For conductors larger than 300,000 circular mils, these strands should consist of very small conductors and should be twisted and united in a manner such as will give the greatest possible flexibility. The ease with which a conductor is pulled through a conduit greatly depends on the flexibility of the conductor.

The conduit should preferably consist of an iron or steel pipe having an insulating lining. The lining may consist of paper saturated with an insulating compound, which is the kind of lining in the conduit most used at the present time. Or it may consist of two or three coats of some enamel or paint baked on the inside of the tube. The former lined conduit has now been in use for several years and given fairly good satisfaction. The conduit with the enamel lining is a more recent innovation and is yet to be proven and tried. One thing is certain, however, and that is that a conduit with an enamel lining is far superior for the purpose of wiring to one having no lining. The last named has the advantage of enabling a conduit of smaller diameter to be used or a conduit of the same outside diameter with a thicker metal wall.

It is to be presumed that the route for the feeders and mains has been already laid out and the space allotted.

As the installation of the feeders and mains may be and generally is divided into two sections, viz., the horizontal portion and the vertical portion, we will consider them under these heads.

The Horizontal Portion.—This portion of the feeder conduits is generally confined to the cellar or first floor of the building and includes that portion of the feeders from the point where they originate (the switchboard) to their respective rising points. As the switchboard (or main cut-out, as the case may be) is generally located in the cellar, the conduits for the feeders are generally shown on the plans to be run exposed on the cellar ceiling or to be run under the floor above. Owing to the size or number of the feeder conduits, the space limitations, other pipes, ducts, etc., and for other reasons it is frequently necessary or desirable to modify or depart from the route or location shown on the plan.

As in the case of exposed wiring, the installation of the feeders should be started at the switchboard. When possible, each conduit should start directly above the switch with which that feeder connects.

Owing to the limited space between the beams and the floor above, it is generally necessary to run the feeder conduits on the cellar ceiling. When this is done the conduit must be firmly secured by hangers or clamps fastened to the beams overhead. These hangers should be placed not more than eight, or at the outside, ten feet apart and should be heavy and stiff enough to support the tubes without bending. These hangers may consist of channel (or T) iron or else of a frame formed of iron pipe. The former is the better and probably the cheaper method. The supports for the hangers may consist of beam clamps or rods passing through the flanges of the beam and pinned above the flange, or else of iron rods passing through the floor arches and secured to flat straps laid above the arches. In the case of a building of wooden construction the hangers could be secured to the wood beams with heavy "lag" or "wood" screws.

Where the head room is sufficient the feeders may be run in two or more tiers.

When there is sufficient space between the beams and the flooring of the floor above the cellar, it is usually better to place the feeder conduits under the floor above. This obviates the necessity of hangers and usually results in a considerable saving in materials and labor. Where the flooring is of wood, however, care should be taken to leave space at intervals for the sleepers, in order that a good fastening for the rough wood floor may be obtained. Where the floor is of concrete, the conduits should be strapped down firmly to the beams or arches, so as to afford a firm and inelastic bed for the concrete.

Vertical Portion of Feeders.—It is presumed that special chaces or spaces have been provided for the rising portion of the feeder conduits. These conduits should be supported by clamps or brackets at least every twelve or fifteen feet.

A good support for the conduit is obtained by clamping the conduit at each floor to the beam, if there be a beam in or at the rising space; if there be no beam the clamp may fasten in the wall or else rest on a pair of iron bars placed across the chace. This clamp is frequently placed under the coupling on the conduit, which prevents any tendency of slipping. In some instances where the vertical portion of the feeders is direct and where there are no bends or offsets, it is necessary to support or fasten the conductors themselves as well as the conduits. Where the vertical portion is direct and over 75 feet, this precaution should always be taken. This, of course, may only be done by interrupting the conduit and placing a clamp with an insulating bushing around the conductor, the clamp resting on the end of the conduit. Of course this is for some reasons objectionable, and in many cases it may be obviated by clamping the conductor at the upper and lower ends. In some instances, however, the weight of the conductor and the consequent strain is so great as to require supporting at intermediate points. The argument that the conductor sags until it assumes a sinuous form and that the grip thus obtained between the conductor and the conduit is sufficient to prevent the conductor from slipping, does not hold good in the light of experience. I have known a conductor to fall through a tube so fast, even after the horizontal portion had been run (there being a junction box between the horizontal and vertical portions), that it entirely settled that question in my mind forever.

One point not yet mentioned, which is

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equally important in both the horizontal and vertical portions, is the necessity of avoiding steam pipes. Wherever possible a space of at least two inches should be left between steam pipes and the conduits. The insulating compound with which the paper (used for insulating the standard conduit) is saturated, begins to soften at about 150° F. High temperatures are also injurious to the rubber covering of the wire.

Owing to the difficulty involved in pulling large conductors through a run of conduit in which there are more than four elbows or bends, it behooves the contractor to avoid, if possible, having more than four elbows in any of the "runs." Where it is impossible to avoid this and where the runs are long, a junction box should be placed in "the circuit" somewhere where convenient. The feeder wires may then be pulled from their point of origin to the junction and then from the box to their respective terminating points. A good place for the location of the junction or "pull" box is at the juncture of the vertical and horizontal portions of the feeders.

It is sometimes possible to reduce the number of elbows in a "run" of conduit by making offsets or bends to replace the standard elbows, furnished by the conduit manufacturer. It is a very difficult matter, however to bend large sizes of conduits without flattening the pipe or cracking the lining. It takes good workmen to do this properly, and even they will have trouble with it occasionally, owing to soft or thin spots in the pipe. Where it is absolutely essential, however, to make a bend or off-set at the building, the pipe should be slowly heated, and a core of wire or other flexible material should be placed inside the conduit to prevent it from collapsing. The conduit should then be bent so as to form a gradual curve instead of a series of angles, which is the usual result.

## Letters on Practical Subjects

### Wire Gage Numbering.

*To the Editor of American Electrician:*

Why not use all that is good in the Brown & Sharpe system. If there is anything on earth more "fearfully and wonderfully made" than wire gage numbers, I have not found it.

In the Brown and Sharpe system we have arrived, geometrically, at a series of diameters which are shown on the chart in thousandths of an inch; a system so perfect that it has been almost universally adopted in this country. Not content with the completion of a good thing, we have turned a somersault and tried to get back into the old rut of Birmingham numbers. Instead of numbering as the chart naturally suggests, the order has been reversed and the wire having the greatest number of mils is given the lowest serial number, until the old limit of No. 1 is passed and the absurdity is fittingly ended by representing the largest size on the list as $4 \times 0 =$? This, or Nos. 1, 20 or 40, expresses nothing as to the diameter or area of the wire and we must go to the tables to ascertain what a number means.

Why not take from the chart the numbers as well as the diameters and make the number of a wire correspond with the number of mils it has in diameter? If No. 40 was changed to No. 3 we would know at a glance that it had three mils diameter and nine circular mils area. Similarly, change No. 20 to No. 32, from which its area 1024 is quickly found.

There may be reasons in some cases for drawing wires to fractions of a thousandth, but for most purposes those drawn to even thousandths will fully meet needs. Practically this is done now; few wires that I use are drawn accurately to the fractions of mils as given in the tables. I have in hand now pieces taken from my stock, from the best makers; No. 18 gages exactly 40 mils, the tables say 40.303. No. 23 gages a small fraction over twenty-two mils, the tables say 22.571; No. 30 gages exactly ten mils, the tables say 10.025; No. 36 gages five mils, as it should.

F.

### Wireless Telegraphy.

*To the Editor of American Electrician:*

Sir:—Having read a number of articles on wireless telegraphy, I thought the following would be of interest to some of the readers of your columns in regard to the theory of action of the coherer.

The so-called coherer is a small glass tube, in the ends of which are terminals enclosing in the space between them small particles of conducting material.

The simple principle of action of the lightning arrester, which is designed to protect outdoor electrical circuits, is sufficient to drive away any mystery connected with the coherer.

A lightning arrester is connected between both sides of the circuit, and when the induced electrostatic charge is sufficient in quantity it will break through the resistance between the air-gaps and follow the path to earth.

But what happens when this discharge between the air-gaps takes place? The discharge spark produces a path of metallic vapor through the air space, and it being a conducting path, the current from generator will make a short circuit over this conducting path and will continue if means are not provided for breaking this conducting path of vapor.

This same principle is applicable to the coherer. When the oscillatory discharges pass through the coherer there will naturally be a spark between the particles of the conducting material, and of course each spark will be a conducting path for the current of the battery connected thereto, and thereby greatly reduce its resistance. Means must be provided for breaking this conducting path between each particle, which is accomplished by hammering on the tube of coherer and causing the particles to change their relative positions, breaking each path of vapor.

Apparently the same result could be obtained by using a magnetic blow-out instead of hammer.

Some authorities claim that its action is produced by the waves falling directly on it, and also that it must have a certain definite position, which to me is apparently absurd.

S. P. Thompson's text book on Elec. and Mag. says that the line of oscillation of the oscillatory wave should be parallel to the line of the oscillation of the receiver; the receiver being the wings and the conductor connecting them, in which is placed the coherer.

The electrical surgings in the receiver are caused by the waves falling on the entire conducting length of the receiver from one wing to the other.

It is then obvious that it matters not in what position the coherer is placed, only so that the conducting part of the receiver external to the coherer is in the line of the induced oscillation.

In a lecture before the Royal Institution of London, the author stated the following: "Another apparent anomaly was that Marconi's relay acts even when placed in a metallic box."

From the above arguments it is obvious that the coherer may be screened ever so much from the waves and yet act.

The author also stated that it has been suggested that we have in the measurement of the variable resistance of this instrument (coherer) a means of determining the intensity of the energy falling upon it. This suggestion is also apparently impossible.

Not having the apparatus to experimentally verify the above arguments, I will leave them for criticism.

EDW. J. FRIMAN.

Hanover, Pa.

### A Mild Puzzle.

*To the Editor of American Electrician:*

My attention was directed to Mr. J. C. Brown's "mild puzzle" in your February number, by the reply in your March issue of Mr. R. L. Johnston, of Bangor, Me., who makes the novel proposition, that impressed and counter e.m.f.'s, are uni-directional and additive.

As Mr. Johnston's reasoning is palpably incorrect, I beg to present the following as the solution, viz.: That the pressure on the mains was either 115 volts, instead of 110, from the inception of the test, or, provided Mr. Brown actually measured the voltage at commencement, that an increase in potential was effected, and existed when the voltmeter at lamp terminals showed 115 volts; in other words, the voltmeter at lamp terminals simply measured the difference in pressure between the mains from which the lamp

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was in reality being fed. In substantiation of the foregoing, I desire to present the following reasons:

The dynamo must either generate a pressure in series with that of the line, or in opposition to it; the former fulfilling "booster" conditions; the latter "motor," if the e.m.f. generated is below that of the line, "generator" if above.

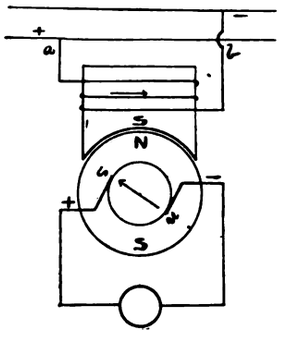


FIG. 1.

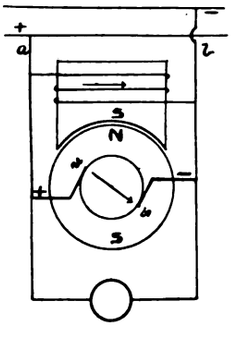


FIG. 2.

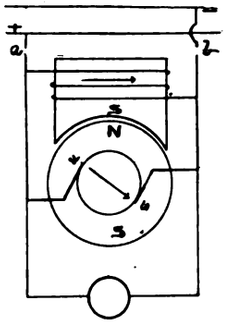


FIG. 3.

If the "booster" condition existed, a short circuit would result, between the negative bus-bar of generator at power station, and the positive brush of "booster," the extent of the short circuit depending on the resistance of the return; the "motor" condition is hereafter described, and the "generator" is untenable with increased speed manifestation.

In Fig. 1 let the main tapped by "a" be positive, and that by "b" negative. The field having a right-handed winding a south pole will be created in the pole-piece shown; assume the armature is wound left-handedly, then with a right-handed rotation (as viewed from commutator end) in this right-handed field, the left-hand brush will be positive, with a pressure of 100 volts existing between it and negative, and the armature will be magnetized as shown in the figure, the block letters denoting polarity induced by fields, and the smaller letters the poles created by armature current, resulting in field demagnetization, the arrows indicating direction of current in field-winding and armature.

In Fig. 2 when the mains are thrown on the brushes, the impressed e.m.f. exceeds the generated e.m.f. and sends a current through the armature in the same direction as the effective pressure, and in a reverse direction to that shown in Fig. 1. We now have a motor with a lead at brushes instead of a trail, and the armature current consequently has a magnetizing instead of demagnetizing effect on the fields, assisting in the production of a more powerful rotation; the quondam generator speeds up and drags the armature of the driving motor ahead with it.

A little consideration will show that as the counter e.m.f. of armature approaches the value of the impressed e.m.f. the machine in nearing the "generator" stage, when the driving motor would be again called upon to exercise its function. So soon as it exceeds the impressed voltage the dynamo again generates, excites its field, supplies lamp and voltmeter, as well as feeding to the circuit, and the armature conditions are again as represented in Fig. 1, the speed consequently dropping to its former value, an effect which did not occur.

Again, if the voltmeter registered the generated pressure of dynamo, when the connections "a" "b" were broken as in Fig. 3, the machine would continue to run as a shunt-wound generator, precluding the last effect observed by Mr. Brown.

Breaking the connections "a" "b" with the machine still acting as a motor, the currents circulating as in Fig. 2, the induced currents in field and armature (shown by arrows in Fig. 3) each tend to neutralize the other, destroying the field, or nearly so, the armature being left practically short-circuited with field winding, voltmeter and lamp, the voltmeter as a result registering zero.

I believe from the above considerations that the voltmeter simply indicates the pressure on the mains.

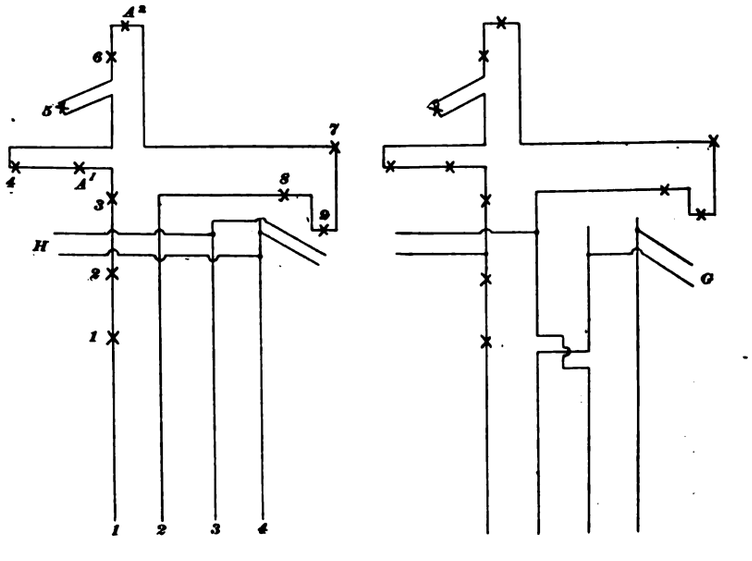
R. C. Harris.

## The Crossing of an Arc and Alternating Circuit.

Some interesting and puzzling phenomena, caused by the mistakes so frequently made by outside wiremen of interchanging arc and alternating lines, are reported by Mr. W. H. Coleman, superintendent and treasurer of the Andover Electric Company, Andover, Mass. The circuits are shown in the accompanying drawing, the left-hand sketch showing the proper arrangement, and the right hand the lines as some telephone wiremen who rearranged them got them twisted.

The results are best described in Mr. Coleman's own words, as follows:

"On the arc circuit there were 10 No. 12 T. H. lamps, three 25 c.p. 13.22-volt 6.8 ampere incandescents between the station and where the cross connections were made, and within a distance of a mile were those marked on the figure. Beyond this there were four arc and five more incandescent lamps. Those nearest station and beyond the crossed district burned all right. Within the section the result was as follows: Incandescents 1 and 2 no noticeable change; the lights on the transformer H would burn all right for a short time and then seem to follow the action of regulator on arc machine. From transformer G the lights were about half candle power all the time, with no change up or down. Arc lamp $A^1$ was not up to candle power, but steady; arc $A^2$ burned all right. Incandescents 3 to 9 were most of the time very bright.



THE CROSSING OF AN ARC AND ALTERNATING CIRCUIT.

The voltage on alternating line 1000, and that on arc 2250. The alter ing machine was a 100 kw. General E tric, and the arc an L. D. 12 G. E. machines worked all right, and no ble was experienced on any other se of line. I found the voltage on secor of transformer H from 109 to 100, down to 94, on transformer G from 1 41—time run from 6:30 P. M. to 1 No trouble from transformers or n since the date of cross connection, 25, 1898. Should like to hear the op of your readers on the above mixtu

W. H. Colem

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# Electrical Catechism

*304. What is an ohm-meter?*

This is an instrument sometimes used for measuring resistance where it is desirable to test with a high voltage, but where none is available except as supplied by the testing outfit. It consists of two parts, a small hand dynamo capable of generating 100 volts or more, and the instrument proper. The latter has two coils at right angles to each other, and a magnetic needle, which takes a position between the two coils according to the relative currents in the coils. One coil is

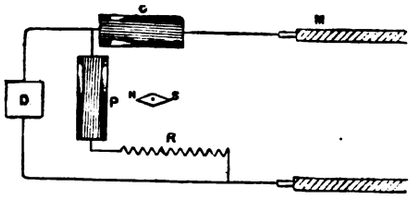



DIAGRAM OF AN OHM-METER.

connected between the dynamo and one terminal of the circuit whose resistance is to be measured; the other coil is connected in series with a high resistance inside the instrument so as to form a shunt across the main circuit, as shown in the figure. When the dynamo is operated, the current divides, part going through the coil *C*, and then through the main circuit whose resistance is to be measured, while the remainder goes through the coil *P*, and the high resistance *R*. The currents through the two coils are inversely proportional to the resistances in their circuits, since the same voltage is applied to both, and therefore they attract the needle correspondingly. For a given voltage of the dynamo, the attraction of coil *P* is constant, while the attraction of coil *C* becomes greater as the resistance in the main line becomes less. The pointer attached to the needle will therefore move toward *C* as the resistance in the line becomes less, and the scale may be divided to indicate the resistance in the main circuit.

*305. For what range of resistance is the ohm-meter suitable?*

It will measure resistances from about five meg-ohms (5,000,000 ohms) down to about 1,000 ohms. It is convenient for measuring the insulation resistance of wiring in houses that are not yet connected with the supply circuit.

*306. What is a Wheatstone bridge?*

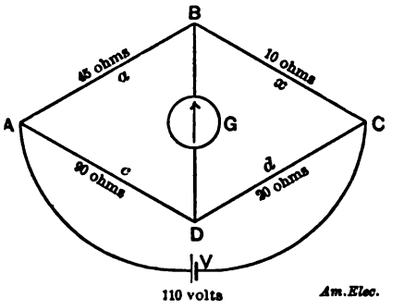
The Wheatstone bridge is an arrangement of resistances with a battery and galvanometer for measuring resistances. It usually consists of two "proportional arms", of such values that one arm has one, ten, one hundred or one thousand times the resistance of the other arm. The third arm is divided into tenths, units, tens, hundreds and thousands of ohms. The resistance to be measured becomes the fourth arm. When the bridge is balanced, the unknown resistance has the same ratio to that of the divided arm as one of the proportional arms is to the other.

*307. What is the theory of the bridge?*

Suppose we have two conductors connected in multiple, and having a battery or other source of current applied to their terminals. The potential would fall from one end to the other in each wire, and for any point in one wire, a corresponding point in the other can be found at which the potential has fallen the same amount. If a galvanometer is connected between these two points, no current will flow since there is no difference of potential between its terminals. We have a close analogy in the case of a river which divides and flows around an island; the water at every point along a line across the river at the head of the island is at the same level; also every point in another line across the river at the lower end of the island is at the same level; if the water flows along the two sides of the island without any sudden falls, for any point on one side of the island, we may find a corresponding point on the other side which has the same level; between these two points no current would flow if a canal were dug between the two. In the Wheatstone bridge the galvanometer circuit corresponds to the canal across the island, and when no current flows through the galvanometer it shows that the two ends of the circuit have the same potential. If then we know that one end of the canal is one-tenth of the total fall from the upper to the lower level, we are sure that the other end is at a corresponding point.

*308. Give an example illustrating the principle of the bridge.*

To better fix ideas, we will take electric

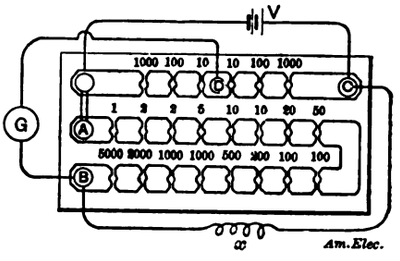



THE CIRCUITS OF A WHEATSTONE BRIDGE.

light currents and voltage, as indicated in sketch. By Ohm's law, $C = \frac{E}{R}$, the current in *A B D* is $110 \div 55 = 2$ amperes; in *A e D*, $110 \div 110 = 1$ ampere. The drop ($E = C\ R$) from *A* to *B* is $2 \times 45 = 90$ volts; from *A* to *C*, $1 \times 90 = 90$ volts. Therefore, the drops to *B* and *C* being the same, the potentials at those points will be equal, and no current will flow through the galvanometer, *G*. That is, when $a \times d = c \times x$, the bridge is balanced. This may be expressed,

$$x = \frac{d}{c} \times a.$$

In practice, the resistances of the two wires, *c* and *d*, are fixed in a certain ratio for a given measurement (in this case, 20:90, but usually as 10:100 or a multiple of 10), and the value of *a* varied until a balance is obtained. A commercial Wheatstone bridge is shown herewith, with the parts lettered to correspond to the above, *x* being the resistance under measurement. In this case, *c* is the left part of the upper row, *d* the right part, and the two lower rows correspond to *a*. If *c* were plugged for 1000, and *d* for 10, and if 1425 plugged in *b* brought a bal-




A WHEATSTONE BRIDGE.

ance, then the value of *x* would be 14.25 ohms.

*309. Is it safe to use a bridge on a 110-volt circuit?*

Not ordinarily. The example given was simply to explain the theory. In practice, only two or four volts are commonly used, although in measuring high resistances, it is sometimes desirable to use higher voltages. The current should be kept on only a very short time, in order to avoid heating the bridge and so changing its resistances.

*310. What range of resistances can be measured conveniently with a bridge?*

It depends largely upon the bridge and the galvanometer. The best bridges will measure from 0.000001 to 111,000,000 ohms. Ordinary portable bridges will measure from 0.01 to 1,100,000 ohms with fair accuracy.

*311. Are bridges suitable for testing the resistances of armatures of large dynamos?*

They are not usually considered accurate for such purposes, since the resistance when running is apt to be different from that when standing still; such resistances should always be measured when the machine is hot and carrying current, and for such work an ammeter and a low reading voltmeter are more reliable.

*312. Is a bridge suitable for testing insulation resistance?*

Not if the insulation is to be used for high potentials. The reasons for this are two: insulation for high potentials should be tested not so much for ohmic resistance as for its ability to stand the high potentials; again, the resistance with a low potential may be quite different from that with a high potential, on account of the electrostatic attraction between different parts bringing them closer together.

*313. How should insulation be tested for high potentials?*

In testing apparatus at the factories, it is common to subject all parts supposed to be insulated, to a difference of potential several times that which they are to stand in use.

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# Queries and Answers

How can the ring for the ammeter described in the October, 1898, number of the American Electrician be permanently magnetized without winding wire upon it

C. O.

By bringing the metal of the ring into contact with the north pole of a dynamo and rubbing the latter around to one pole of the ring and then pulling it off, following this by bringing the middle of the ring into contact with the other pole of the dynamo and rubbing it around to the other pole of the ring; the two processes being alternately repeated the ring can be fairly well magnetized.

Three plates of a 12 ampere hour chloride accumulator loose capacity. Negative plates show no white deposit, but become a general blackish color with a slight deposit of black powder over affected parts. The rubber bands used to bind the plates together are dyed a rusty red at the four corners and this dyeing is only noticeable in the cells affected. The electrolyte is made from chemically pure acid diluted with water supplied from a lime rock district. Can find no cause for the defect and the other cells in battery are in good condition. What is the trouble and remedy? A. M.

The plates should be removed from the electrolyte and carefully scrubbed in clear water, using some cheap form of hand scrubbing brush. Care should be taken not to spread the negative plates of the elements too far apart, as they may be broken from the connecting strap, but if the work is done carefully the deposit referred to can be removed. It is possible that the difficulty was caused by the water, and either rain water or distilled water should be used in its place.

What current from a 110-volt circuit will be required to heat a quart of water from 70 to 210 degs. in five minutes? What should be the size of the wire? A. L. S.

Taking the weight at 2 lbs., 2 (210—70) = 280 heat units will be required, which are equivalent to $280 \times 778 = 217{,}840$ foot-pounds. Dividing by 33,000 gives 6.6 h.p.-minutes, or 1.32 h.p. for five minutes. Since there are 746 watts in a h.p., we have 984.7 watts, or 9 amperes at 110 volts. Allowing for heat losses, probably 12 amperes would be required. The resistance will be $110 \div 12 = 9.2$ ohms. The gage of the wire will depend upon the temperature it will stand. No. 22 iron wire will probably do.

What is a direct-current transformer? A. D. H.

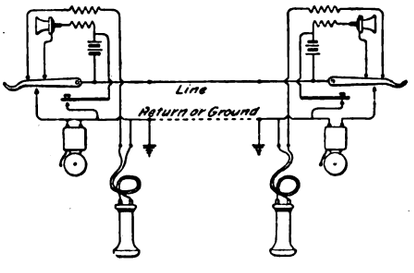
A machine for transforming a direct-current voltage—called usually a dynamotor or motor-generator. It may consist of one armature with two windings and two commutators, or two identical machines direct-connected, one running as a motor and the other as a generator, the motor voltage being different from the generator voltage.

What is the difference between cycle, period, frequency and alternations? A. R. B.

Cycle and period are synonymous. The frequency is the number of cycles or periods per second, and an alternation is half a period. A cycle refers to the time required by an alternating current to rise from zero to, say positive maximum, fall to a negative maximum and return to zero.

How can the battery of a microphone and induction coil circuit be used for ringing a bell or buzzer at the other end of the line? W. E. C.

This can only be accomplished when the line is short, so that the low voltage battery used in microphones will deliver sufficient current to ring an ordinary bell. The instruments should be wired according to the accompanying diagram, which is self-explanatory.




Will I infringe any patent rights if I make and sell the field of a dynamo similar to that used on Wood arc machines? Also, what are the disadvantages of this field? R. G. P.

No. The broad patent rights on all but a few peculiar types of field magnets have expired. The advantage of the Wood arc type is the support of the shaft in the yoke of the magnet without special pedestals. The disadvantage is the necessity of taking down the field magnet to remove the armature.

I desire to run three dynamos in parallel, two of the same size and one larger, for incandescent lighting. Should I use the rheostats now in use to keep any one machine from taking more than its share of the load or will I need some other arrangement for the purpose? H. S. C.

Yes. The same rheostats will apply.

Can you advise me of a table of the current carrying capacity of iron wire when used as a resistance in sizes from No. 4-0 to No. 8? J. C.

Round iron wire in such large sizes is rarely used and probably no table of its carrying capacity has ever been published. In an article by Mr. P. M. Heldt in the "American Electrician," March, 1897, the carrying capacities of sizes down to No. 8 were given. The capacity of larger sizes can be readily estimated from the following considerations. The cross-section of wire doubles for every three numbers in the Brown & Sharpe gage, while the surface area per unit length doubles for every six numbers. For example: No. 5 wire has twice the cross-section of No. 8 and No. 2 has twice the cross-section of No. 5 and twice the surface area of No. 8. To obtain a uniform dissipation of energy per unit surface area the carrying capacity may be assumed to double for every 4 numbers in the gage, thus No. 4 wire would have twice the carrying capacity of No. 8, which is given by Mr. Heldt as 17 amperes in a wooden frame and 20 amperes in an iron frame.

Can you tell me if 1 h. p. delivered by a steam engine makes 746 watts? I have a two phase generator of 2200 volts and 68 amperes. How can I tell what horse power it will take to run it up to 68 amperes? W. J. L.

Theoretically 1 h. p. indicated upon the steam engine should give 746 watts, but practically there are many losses, so that only about 400 to 600 watts are obtainable. Small, inefficient machines give the lower figure, and very large generating sets the higher one. The dynamo will require theoretically 400 h. p. when giving 68 amperes on each phase, practically about 450 h. p. will be needed.

Is it advisable to have the ground wire of an alternating machine in the same ground with that of an arc machine, and is an iron bolt driven in rock or stone a good ground? H. F. W.

There is no objection to having the ground wires of any number of circuits connected to the same ground if the latter makes a good connection, but the ground which you describe certainly does not do so. In a stony or rock formation a good ground can be obtained by going down to the level of permanent dampness and laying there a considerable surface of metal, such as old steel rails, sheet copper, old piping or similar second-hand material. This should be carefully connected by soldered joints to the wire from the switchboard, all such joints underground being painted to prevent their corroding.

I have built a small series dynamo with an ordinary cast-iron shuttle armature. The machine works all right when excited by batteries, but otherwise it gives a small current and refuses to build up. What are the troubles? E. K. M.

Very small machines with solid iron armatures, unless they have a very narrow air gap and run at a high speed, are only with difficulty made to build up at all. It would be well to try higher speeds and more turns of wire in the series field. It is more than likely that so much series field would be required that there would be little energy left for the external load.

What is the formula for calculating reactance between wires of the same alternating current circuit and for getting the drop and potential in all lines? D. U. S.

The method of calculating the drop in alternating current lines having self-induction was described in the "American Electrician" of June, 1897, by Ralph D. Mershon.

What is the usual per cent. loss in watts in transforming a current? D. U. S.

Very large transformers of several hundred kilowatts have efficiencies at full load running up to 98½ per cent., i. e., they lose only 1½ per cent. of the power transformed. Small transformers of 20 light and 40 light, etc., lose from 5 to 10 per cent. at full load and a greater percentage at lower loads. In ordinary house to house service where only a few lamps are on during a short time in the evening while a transformer is wasting energy all day long, the average efficiency falls as low as 60, 50, or in extreme cases 40 per cent.

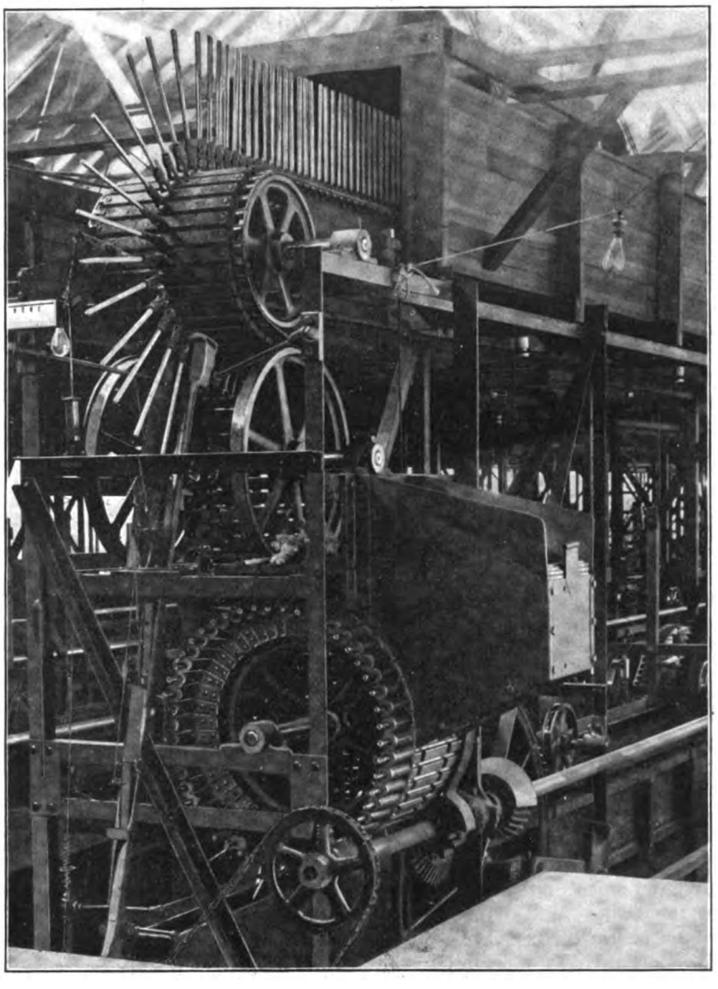
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## CARBONS.

FOR ARC LIGHTING, BATTERIES, TELEPHONES, BRUSHES, ELECTROLYTIC AND OTHER PURPOSES; HOW AND WHERE THEY ARE MADE.

Carbon, in some form, is usually a prominent factor or element in every machine or appliance employed for the production or use of electric energy. The human eye seems to be so designed that it is co-related to the light rays given off in the burning of carbon, so that this substance, in some form, has been employed by men for light in all the ages, from the pine knot and animal fat in primitive times to the latest developments of modern lamps, whether oil, gas or electric light. To tell how it is refined and fitted especially for electric service is the mission of this article. The facts which form the basis of the story were ascertained on a trip to Cleveland, where a visit was paid to the works of the National Carbon Company, which are located near the western limits of the city.

These works are of special interest, being, it is claimed, the best equipped and most extensive works devoted to this industry in existence. The buildings are of brick, seventeen in number, arranged in parallel lines, and cover twenty-three acres, in which about eight hundred men are employed. The products are not by any means confined to lighting carbons, but embrace a great variety of chemical battery elements, as well as complete primary batteries for all purposes; also telephone transmitter parts, including back plates, diaphragms and their companion granules or carbon shot; also carbon motor and generator brushes, lightning arresters, rods and strips of various sections, including those of large diameter employed as smelting electrodes and for electrolytic purposes.



THE AUTOMATIC PLATING MACHINES.

To write the full history of the material from which the ordinary lighting and battery carbons are produced, it would be necessary to visit the Pennsylvania petroleum wells, and ask of nature the secret of its production and then follow it to the tide-water refineries, for the material is known as coke and is a by-product of the process of oil refining, being the solid product or residuum that remains in the stills of the refineries after the oils have been evaporated. This is delivered to the carbon works by the car-load and comes in irregular chunks or bodies of black porous material, somewhat lighter than coal-coke. This material is stored in great quantities in a long pile thirty feet high in the receiving department, which occupies one end of a long building, the other end being occupied by the calcining retorts and cooling floors.

It is first ground in a vertical bark mill to what is known as pea-size, and from this, by means of belt elevators, it is stored in large iron tanks above the retorts. From these it is drawn into small iron cars which run along on top of the retorts and discharge their contents directly into the calcining ovens, where it is subjected to a high temperature by the burning of gas, which is manufactured from coal on the premises. The ovens are kept closed so that the material burns in its own gas, by which process all the volatile matter and other impurities are consumed, leaving the charge virtually as pure carbon. In the process of calcining, the gas is turned on or off by degrees, and, after cooling to a certain degree, the material is hauled out through doors in front and falls into a metal trough running along in front of the retort, in which is a link belt conveyor, by means of which it is delivered to a point near the middle of the building, where it is again elevated, and by means of a conveyor directed along above a long iron floor, to which it falls through flexible chutes, which, by being properly manipulated, deliver it in an even layer over the floor, where it is left to cool.

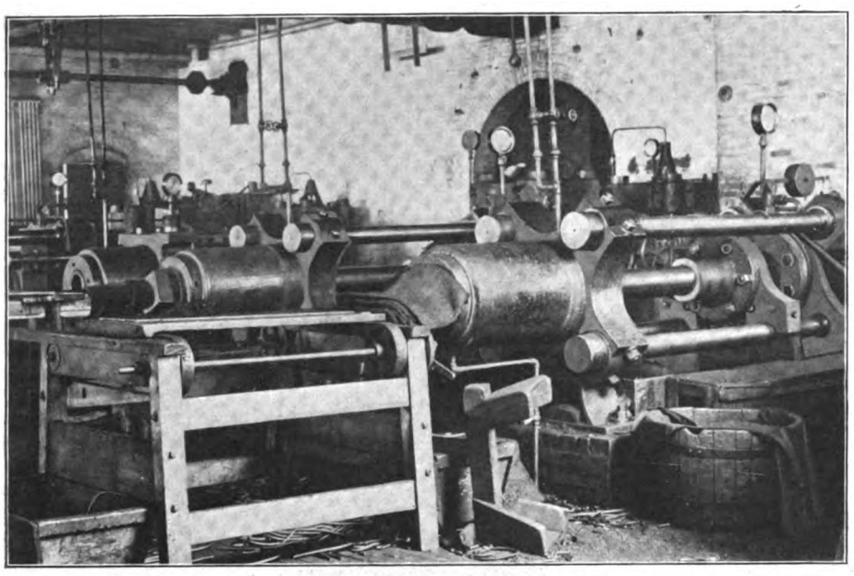
From this floor it drops to a conveyor, which delivers it to an adjoining building, where it is again elevated and delivered to the grinding mills, of which there are a number, both vertical and horizontal, the latter of which are similar to the burr stone mills employed in grinding grain. From these, by suitable conveyors, the powdered material is delivered to a set of bolting machines by which it is separated into different grades, the coarser grades being returned and reground, as is also all scrap from imperfect carbons. Following the bolting process, the material is delivered to the mixing room, where are a number of iron barrels or boxes, which revolve like the rattlers used in foundries. These are heated by steam and in this process the binding material is incorporated with the carbon powder.

The binding material is a product which has also been prepared by a special process and which has been ground and bolted in about the same manner as is the carbon. Being suitably mixed, the material is conveyed to a cooling department, where it is made ready for the molding or forcing process.

In the making of the lighting pencils two processes are followed; one is known as the molding process and the other the forcing. In the former the material is carefully weighed and then placed in the molds, which consist of grooved plates of steel containing from twelve to eighteen forms, depending upon the diameter of the pencils to be molded. An attendant carefully packs and adjust the material, then smooths it off with a straight-edge, but there is no excess of material, so accurate is the weighing process. The molds being in two parts, the second or upper part is now placed upon the powder and pressed down with the hand, when it is ready for the press. The molders occupy little booths with tables on each side of a pair of endless chain conveyors which run in opposite directions, and upon these the molders place the filled molds, which are then conveyed in the direction of the hydraulic presses. Before reaching the latter they are led over a slow-running conveyor which passes through a furnace heated by gas, and when they emerge they are placed by an attendant upon the head of the verti-

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cal plungers of the presses, of which there are two, one on each side of the line of conveyors. A second attendant manipulates the valves, when the two parts



THE JUMBO FORCING PRESSES.

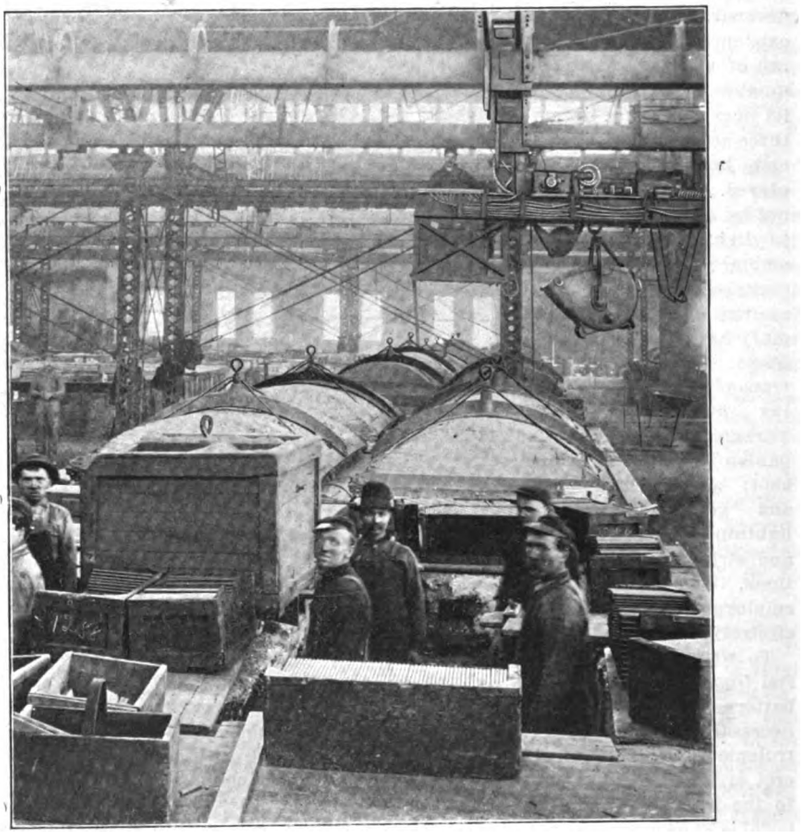
of the mold are pressed together with great force and then released, when the attendant removes the mold and its contents from the press and places it upon the return conveyor, by which it is taken back and removed by each molder as his mold comes in position.

The molds are returned still hot, and each molder, after removing the formed pencils, which are held together by a thin web of material, places them upon a corrugated pan, on which they are held straight until cool, and by which they are removed and conveyed to the stripping room. To refill the molds the attendant first gives them a coating of oil and then weighs out the material as before described. There are a number of molders employed to each pair of the chain conveyors, and there are several pair of conveyors. In the stripping room the pencils are broken apart by hand and deftly fed one at a time into the strippers, which automatically draw them through very rapidly and shave off the portions of the web that may adhere to the sides of the pencils. At this work some of the hands become very expert, being able to break apart and feed into the machine more than a hundred pencils a minute. From this department the pencils go to the baking furnaces.

We will now follow the material as it is formed by the forcing process; and, in this department, we find a number of presses which are large horizontal machines called Jumbo presses, having cylinders of large diameter in which plungers are fitted and by which the material is forced through dies in the outer end of the cylinder. Before it is placed in the presses the material is formed into compact cylinders by hydraulic pressure; then these billets are fed one after the other into the cylinders of the press. The size of the rod or form depends upon the die; and, for making the lighting pencils, the material is forced out into grooved trays and broken off in lengths of about four feet, in which they are left for a time to cool, after which they are cut up into various lengths by being placed in a frame with suitable adjusting and cutting appliances. The same process is followed in forming the large rods employed for electrolytic purposes. Some of these are three inches or more in diameter.

The baking process follows and all types of carbons are subject to about the same degree of heat. The baking furnaces occupy one of the largest buildings, covering perhaps six acres, which is provided with three large brick smoke-stacks that provide a draft for the entire lot of furnaces. These furnaces are constructed of fire-brick and are provided with a removable arched roof; the roof being composed of fire-brick, but held in shape by means of bars of channel iron, and so designed that they can be removed and shifted about from one furnace to another by means of overhead traveling electric cranes. The furnaces are filled with the pencils, which are carefully piled in regular rows with a thin covering of carbonizing material between the layers; and, when filled, the surface is covered with a kind of clay which vitrifies in the process of baking and covers the bed with a scale so that the gas which is employed as fuel does not come in contact with the carbon. The process of baking requires eight to ten days, and the fuel gas is manufactured on the premises. After being allowed to cool, the top of the oven is removed, when the pencils are lifted out by means of forks, not unlike hay-forks.

Being placed on suitable racks, the carbons are next delivered to the inspecting and sorting rooms, where they are carefully sorted and tested for straightness. For this purpose they are allowed to roll down the incline surface of a steel plate in such a position that the attendant is able to detect any crookedness in the pencil by means of the light rays that can be



THE BAKING FURNACES, WITH CRANE FOR SHIFTING FURNACE LIDS.

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seen between the plate and pencil. From thirty to forty hands are employed in this work. They are usually sorted into three grades, known as No. 1, No. 2 and culls; only the No. 1's, however, are employed for long pencils, the others being cut up into short lengths designed for use as the lower carbon of a lamp, being usually about seven inches in length, while the ordinary length of the long pencil is twelve inches, and in some cases fourteen. The culls and seconds usually provide enough of the shorter lengths, so that only the long pencils are molded or forced. Such pencils as have been formed by the forcing process have now to be pointed, and this is done by machines especially constructed and said to be recent inventions, for which patents have been applied for. In the same department are machines for accurately planing motor and generator brushes, in which a number of brushes are clamped in position and are moved along against the face of an emery wheel. In the same department are the machines for filling the cored carbons. The material for this purpose is a secret preparation, and is much like a thick metallic paint, and is ground and mixed in a special designed machine, when it is forced into the cavity of the carbon under great pressure on a hydraulic machine, in which the pencils are placed one at a time and filled about as fast as the attendant can put them in and take them out.

Such pencils and brushes as require to be copper plated are taken to the plating departments, of which there are two, one for the brushes, in which the plating is done in the ordinary manner by suspending the blocks in the electrolytic solution, where they remain until thoroughly plated. Formerly the lighting pencils were plated in the same manner, but more recently new machines, entirely automatic, have been installed. From this process the carbons are delivered to a traveling conveyor which connects with the packing room.

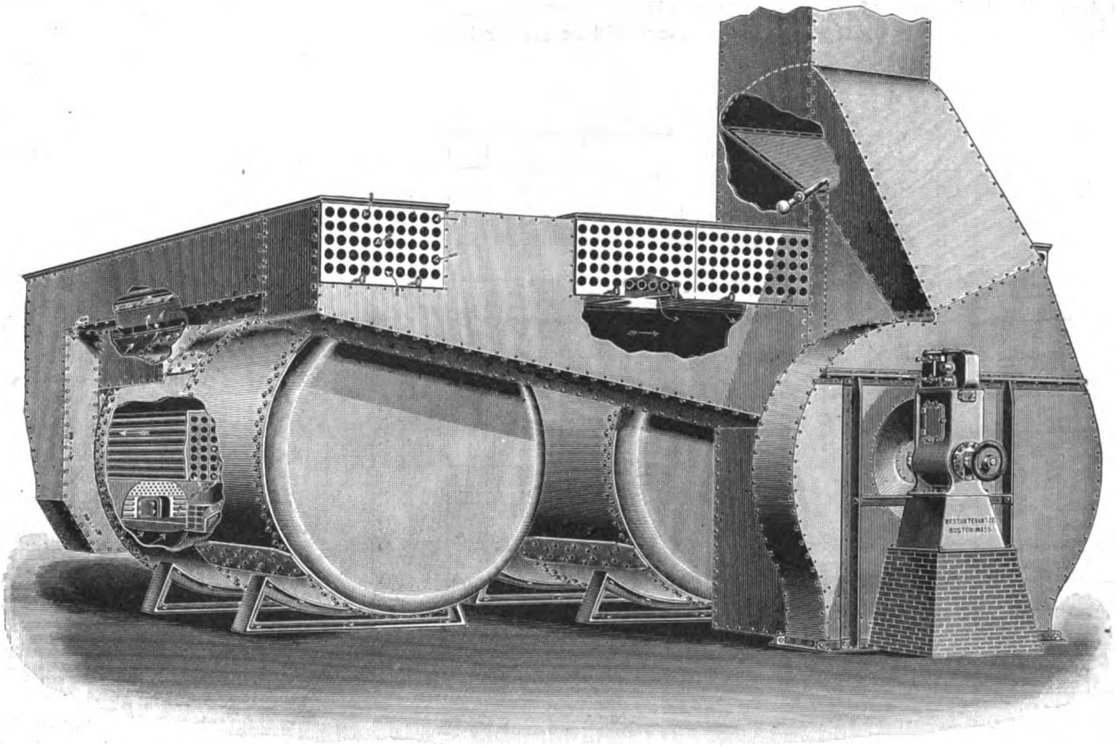
The testing department, which is one of the most important in the production of perfect carbon, occupies a large room on the second floor of one of the principal buildings, and here are provided a number of arc lamps of different types, in which samples of pencils from each furnace are tested for life and efficiency, there being suitable ray testing lenses for determining the light-giving rays.

In order to complete the story of the manufacture of the battery and telephone elements, it will be necessary to return to the molding department, and here we find a large number of hydraulic presses of curious design and various shaped molds in which the great variety of designs are formed, the material in all cases being carefully weighed and packed in the molds, when either a screw or hydraulic pressure is applied. In such batteries as have the cover and cup of carbon, the threads by which the two parts are screwed together are formed in the process of molding. Telephone diaphragms are molded in very thin sheets and cut out in round forms in the process. These various forms, including the battery and telephone parts, are then baked or fired in about the same manner as described for the pencils.

## THE UTILIZATION OF THE WASTE HEAT OF THE FLUE GASES FROM A STEAM BOILER.

No greater waste occurs in modern steam boiler practice than that which is inherent in the employment of a chimney for the production of draft, namely, the loss of heat in the escaping gases. As the chimney depends for its action upon the maintenance of a temperature difference between the internal gases and the external air, it is manifest that with a chimney this waste can never be eliminated. It may be palliated, it is true, by the building of higher chimneys, so that the same intensity of draft may be obtained with a lower stack temperature. But such means of providing for the utilization of the otherwise waste heat are expensive. For instance, if, with an external temperature of 60 degrees and an internal temperature of 500 degrees, sufficient intensity of draft is produced by a chimney 100 ft. high, it will require a height of 175 ft. to produce the same draft when the temperature of the gases is reduced to 250 degrees. In addition, the means provided for extracting this heat will increase the resistance, and provision for overcoming the same will have to be made by a still greater chimney height.

The heat losses incident to the operation of the chimney and the discharge of the flue gases at high temperature are so great as to always warrant a careful investigation as to the possibilities of their reduction. Heretofore the feed water



INDUCED-DRAFT PLANT ON ELLIS & EAVES SYSTEM, WITH STURTEVANT FAN, AT AMERICAN LINE PIER, NEW YORK.

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economizer has been the best known appliance for this purpose, but its utility is necessarily limited. It shows the greatest gain when the normal temperature of the flue gases is high, or when the fuel cost is excessive. The lower the temperature of the flue gases the less the opportunity for saving, and naturally the less the cost of fuel per ton, the less will be the financial saving due to a certain percentage reduction in the quantity of fuel required to produce a given result. In other words, the fixed charges and operating expense upon an economizer may approach so closely to the saving resulting from its use, that its introduction becomes questionable.

To a large extent, the limitations of the efficiency of an economizer have been set by the chimney itself, because of its inability to produce the necessary draft when the gases are sufficiently cooled to show a gain in economy. Any device which can produce the required draft without the waste incident to the operation of the chimney, must of necessity present claims for consideration.

The fan stands as the most prominent factor in the production of artificial draft, and its prime claim for utility in connection with the abstraction of heat from the gases lies in its high efficiency as compared with a chimney. The chimney operates to move the air simply by displacement, due to the difference in density, while the fan acts mechanically to cause the same movement.

Under the ordinary conditions of boiler draft, the fan requires only about 1/75th part of the power, as measured in heat expenditure, that is necessary for the production of the same results by means of a chimney. In other words, the fan renders available for utilization practically all of the heat of the flue gases, and the opportunity is presented for cooling them down to the lowest practicable temperature.

The waste which occurs in ordinary practice is sometimes startling. Messrs. Donkin & Kennedy found in 17 independent boiler tests that the heat lost up the stack when no economizer was used, ranged all the way from 9.4 per cent. to 31.8 per cent. of the total heat of combustion.

The theoretical losses incident to the burning of coal having a heat value of 11,720 B. T. U., with 100 per cent. excess of air, are shown by the accompanying curve. Had the heat value been higher the temperature range greater, or the excess of air over 100 per cent., this amount of course would be greatly increased. At a temperature of 800 degrees, with ordinary commercial coal, and an excess of air of 150 per cent., the waste would amount to about 40 per cent.

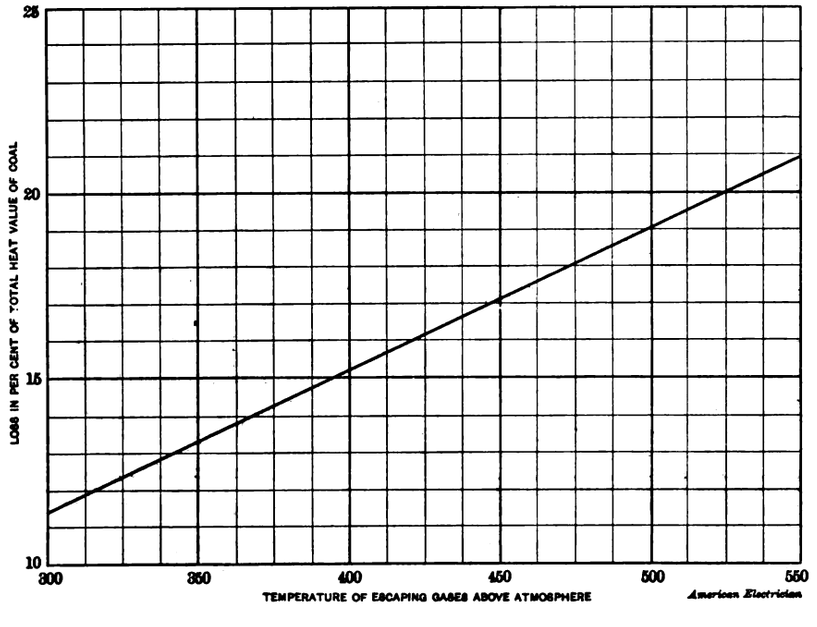



DIAGRAM SHOWING LOSS IN FLUE GASES AT DIFFERENT TEMPERATURES.

With the feed water economizer installed in connection with a mechanical draft apparatus, Roney has shown results of which the averages for nine different plants are given in the following table:

| | Degrees. |
|---|---|
| Temp. of gases entering economizer.... | 526.3 |
| Temp. of gases leaving economizer..... | 269.6 |
| Decrease in temperature of gases..... | 256.7 |
| Temp. of water entering economizer.... | 150.4 |
| Temp. of water leaving economizer..... | 297.1 |
| Increase of temperature of water,..... | 146.7 |
| Fuel saving in per cent..... | 14.64 |

Another means of utilizing the waste heat is coming into prominence in the form of the air heater or heat abstractor. The purpose of this device is to cool the flue gases and co-incidently to heat the air supplied to the furnaces. The limit of heat abstraction is, under these conditions, purely commercial in its character, that is to say, the gases should not be cooled below a temperature which will fail to show a financial gain when the fixed charges of the heat abstracting device are taken into account. In 1881 and 1882 were conducted the notable tests of J. C. Hoadley upon a special form of heat abstractor. All of the factors concerned were very carefully studied. It was primarily determined that a blower was necessary to produce the draft when the gases were reduced to minimum temperature. The results of tests showed a reduction to 162 degrees as the gases escaped to the chimney, the cooling of the gases through 213 deg., and a warming of the air through 300 deg. The heat lost in the gases was thereby reduced to about 5 per cent. of the total heat of the fuel, and about one per cent. of the steam was required for operating the blower. Since then many devices have been introduced for this purpose.

In marine practice the Howden system has assumed prominence. In this device the gases pass through tubes placed in the uptake connections, while the air is by means of a fan forced across these tubes, and thence through a false front to the boiler furnaces. Tests on board the S. S. St. Louis showed a temperature in the funnel of 564 deg. and a resulting temperature in the air reservoirs of 263 deg. This device, as ordinarily introduced, is not particularly adapted for stationary work, although it may be specially arranged for this purpose.

Another form of heat abstractor illustrated herewith is the Ellis & Eaves. This apparatus, shown here as applied to two marine boilers, consists of a series of tubes placed above the boilers. Through these tubes the air is drawn to the ash pits, whence it passes through the fire, the combustion chamber, the boiler tubes and the uptake, and thence around the heating tubes on its way to the fan. The fan operates on the induced principle, the gases passing through it, all objectionable action upon their part being avoided by water cooling the inner journal of the engine.

The particular apparatus located at the American Line Pier, New York City, here illustrated, has shown a temperature of 456 deg. at the fan outlet, and 315 deg. at the air downtake while burning 41.26 lbs. of coal per sq. ft. of grate per hour.

Of course with this type of boiler the normal temperature of the gases is high, but there appears to be an opportunity for further development of an apparatus of this character which may be applied to any ordinary boiler, and will coincidentally decrease the temperature of the flue gases, increase the temperature of the air supplied, and facilitate combustion because of the higher temperature of the air admitted.

A device like this is adaptable under practically all conditions, but very evidently requires a fan for the production of draft because of the great resistances introduced by the abstracting device.

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## THE PERFORMANCE OF WAGNER SINGLE PHASE MOTORS.

An interesting series of tests has been carried out by students of the University of Nebraska, under the direction of Prof. R. B. Owens, with a 5 h. p. single phase motor, such as was described in the last issue of the American Electrician, built by the Wagner Electric Manufacturing Company of St. Louis, Mo. From the results of these tests the following information has been gleaned.

The motor was run with a Prony brake to determine its output and was supplied through a Weston wattmeter to determine its input in energy, and a Siemens dynamometer and Weston voltmeter to determine its apparent input, and hence its power factor. The speed was measured by an indicator consisting of a small magneto generator and voltmeter, and the slip was determined by means of contacts on the motor and generator and a bell circuit connected through both in such a way as to audibly indicate the number of revolutions lost per minute. The curves of efficiency, power factor, slip, etc., with different loads were determined for 70, 80, 90, 100, 104, 110 and 120 volts; three of these, viz., those at 70, 104 and 120 volts, being reproduced herewith to give an idea of the effect of voltage variations on induction motors.

It will be noted in general that the load which the motor will carry increases with the voltage, the slip, for example, being 4 per cent. with a load of only 2½ h. p. at 70 volts, a load of 6 h. p. at the normal voltage, and a load of over 7 h. p. at the highest voltage. The efficiency at normal voltage rises to 78 per cent., the same value being reached at the higher voltage, but only at a higher load, which might be expected from the increased iron losses with the increased density of high voltage. The maximum efficiency at the low voltage is only 70 per cent.

The power factor reaches almost exactly the same maximum value, about 88 per cent., at all voltages, but, as might be expected, this maximum is reached at higher loads on the higher voltages, owing to the fact that they require a greater magnetizing current and therefore a greater energy current must be introduced to bring up the power factor.

In general it is obvious that the machine will operate satisfactorily over a range of pressure from 100 to 125 volts, as wide as that allowable in direct current shunt motors. The iron losses were measured at different voltages with the rotor standing still and the brushes removed, so that there could be no currents through its windings. They showed for 104 volts a value of 200 watts, or about 5½ per cent. of the rated output of the machine. It should be noted, however, that the iron losses would be likely to be less with the motor running, owing to the fact that the frequency of alternations impressed upon the rotor in that case would be comparatively small. Unfortunately the starting torque, the current required therefor and its power factor were not recorded with the motor in its starting condition, viz., with the armature running on the repulsion principle. The report states, however, that "the motor is tble to pull up from standstill more than 50 per cent. overload with no excessive increase over full load current."

An interesting property brought out by the tests was the fact that the efficiency of the motor when hot reached a higher value for practically all loads than when cold, the difference amounting to some 2 to 3 per cent. This was perforce ascribed to reduced iron losses in the hot condition, as the copper losses must necessarily be higher and friction, windage, etc., the same.

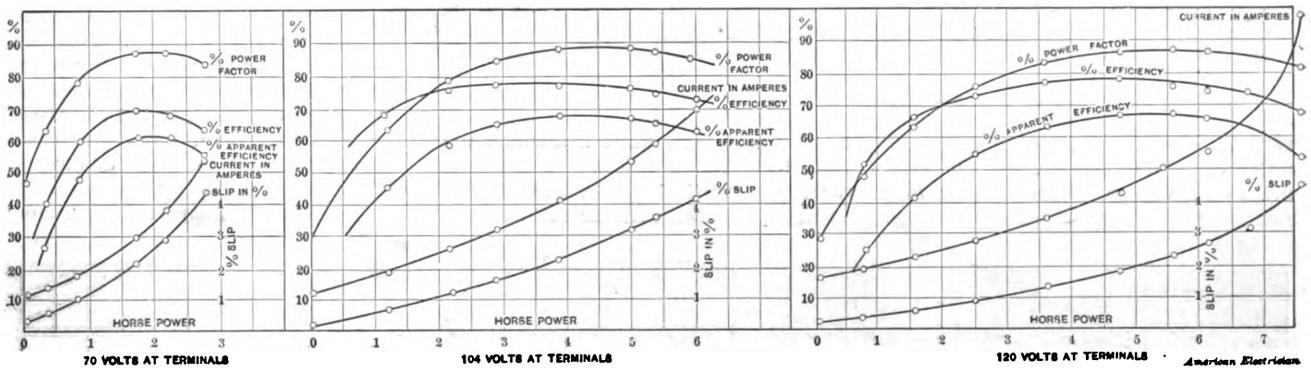
Tests were also made to determine under different conditions the distribution of the flux over the air gap of the machine. This was accomplished by means of test coils wound on different portions of the stator and determinations of the instantaneous e. m. f.'s generated in them by means of an adjustable contact on the generator and the usual battery compensation and telephone indicator. The tests showed a remarkably true rotating field with the rotor running light, there being no discernible difference between the magnetic strength at different angular positions.

While the tests, owing to difficulties which arose, were not completely worked out to determine the distribution under loads, they indicate an elliptical distribution of the magnetism, not differing seriously from a true circular rotary field.

## THE USE OF ELECTRICITY IN THE MINING AND HANDLING OF BITUMINOUS COAL.

History shows that in 1828 the first coal was mined and offered for sale as fuel in the State of Ohio. But great difficulty was experienced in supplanting wood as a fuel by coal, owing to the great abundance of the former, and it took twenty years to get coal used to any extent for house heating or steam purposes. A similar difficulty has been experienced in supplanting the old methods of mining by modern electrical machinery, but now this new power is finding a welcome in this field, both by the operators and miners, and is already in use in bituminous mines in Pennsylvania and Ohio to a greater extent than is generally supposed.

The credit for the introduction and use of electrical appliances in coal mining is largely due to the efforts of the Jeffrey Manufacturing Company of Columbus, Ohio, which is an extensive manufacturer not only of electrical coal cutting and handling appliances, but also of elevating and conveying machinery for all purposes.



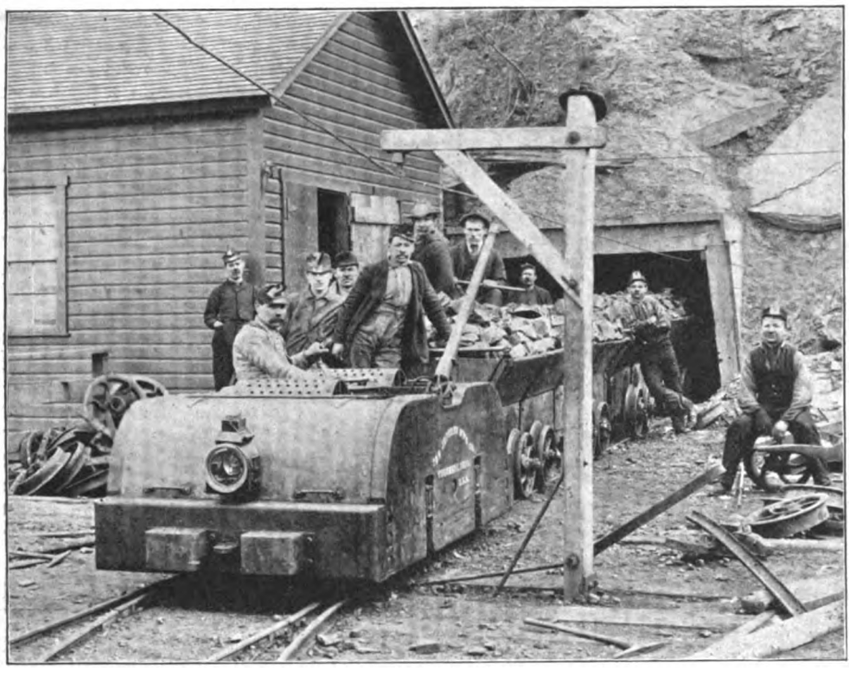

CURVES SHOWING THE ACTION OF A SINGLE PHASE INDUCTION MOTOR AT SEVERAL VOLTAGES.

The most interesting of these appliances are the cutting machines, which make an undercut at the base of the vein, when the drilling is done near the top, so that the face readily breaks down by the use of explosives. The under cutting machines are made in two types, known as 17A and 16A, being distinguished by the motors employed. The former is made for use in thick veins of coal, or in veins from thirty inches in thickness up, and the latter in veins down to twenty inches. The same motor operates the cutter, and propels the machine along the track, when necessary to move from one chamber to another. These machines are shown in one of the accompanying figures and consist of a low steel frame work, with guides and with a shifting platform which carries the motor and the cutting tools. These consist of an endless chain or belt that travels around the edge of the platform, being held in position by guides, and which carries at short intervals chiseled cutting points or knives, set alternately at an opposite flaring angle. The frame being in position with the working end towards the face of the vein. it

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is anchored and braced by means of dogs and jacks against the roof, when the chain is set in motion by power from the motor, and the platform is gradually moved forward by a rack and pinion, forcing the cutter chain into the face of the vein, and so making an undercut about four inches high, and with the large machine seven feet deep and forty-four inches wide. The time required for such a cut is about five minutes, when the platform is withdrawn and the position changed.

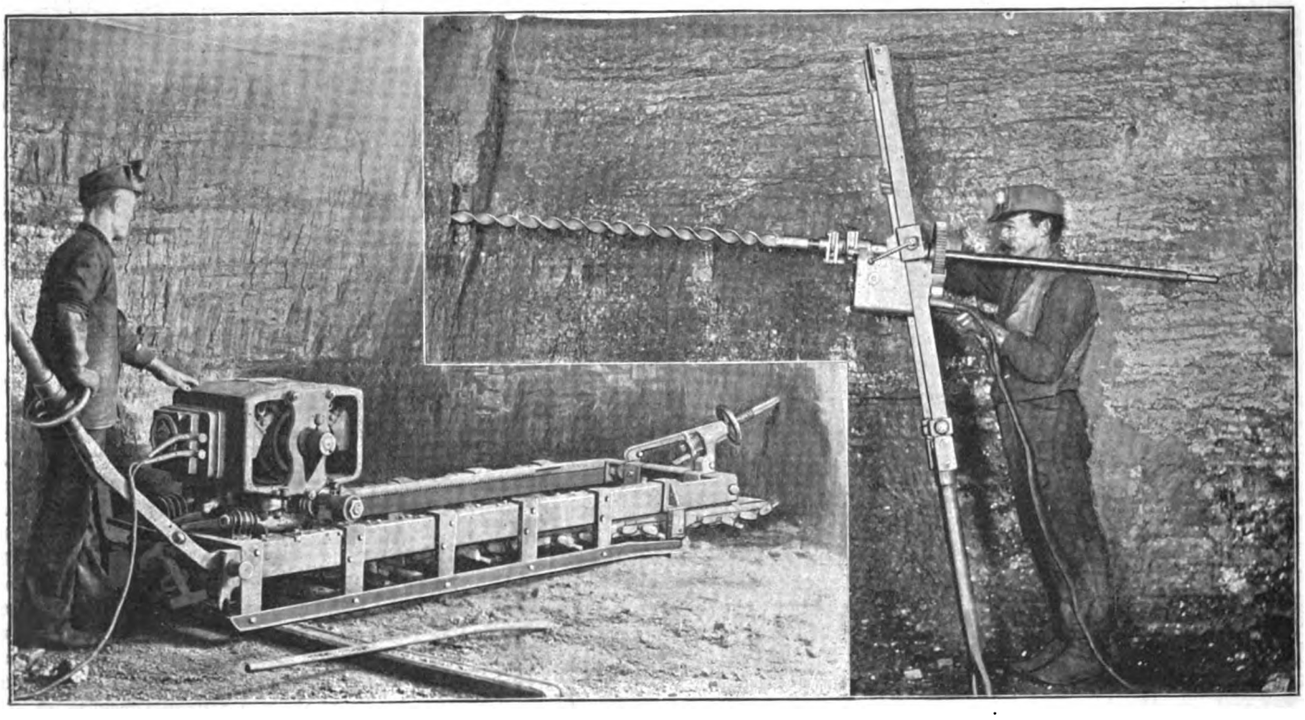
A machine of this description replaces about twenty miners, as the output of coal per miner by the old method, when the vein is reasonably deep, is from four to six tons a day, while a machine will mine from 100 to 150 tons in the same time. The vertical cuts are made with a similar machine, only the cutting chain is placed in a vertical position and cuts a channel up and down in the face of the vein. There is also a third type of machine, known as the long wall type, on which the cutters are inserted in a circular disc or cutting wheel, and which is designed to work in a circular chamber, and cuts a continuous channel all around the face of the vein.



A MINE LOCOMOTIVE.

The drills are operated by means of a small motor, mounted on a standard, or an extension rod, which is supported in a vertical position between the roof and floor of the chamber, and by means of gearing drives a thimble through which the drill is forced as it revolves, and which can be adjusted to any angle.

The electric locomotives are made in different sizes, weighing from two to fifteen tons. These are designed to give a draw bar pull of from 500 to 6000 pounds, and to haul a number of loaded cars, depending upon the grade, equal on the level to a gross load of 180 tons. The frame work of the locomotives is made of cast beams, and the largest machines are about thirty-nine inches in height, and of any gauge from 17½ inches to standard. The wheels are about 28 in. in diameter, with standard journal boxes and running gear. The power is transmitted to the axles by a single reduction gear, in about the same manner as in street railway practice. In some cases the operator is located at the front end, and in others at the middle. The brakes are of the automatically locking screw type, and the controllers of the cylindrical type, with series parallel attachment, and are worked by a lever, with the resistance arranged in steps, to give uniform acceleration in starting a load. The trolley wire is supported from the roof by malleable iron barbed split bolts, which are readily adjusted, and the insulation is of a water-proof pattern, with an air space and a hood to shed water.



A MOTOR DRIVEN CUTTER. A MOTOR DRIVEN DRILL.

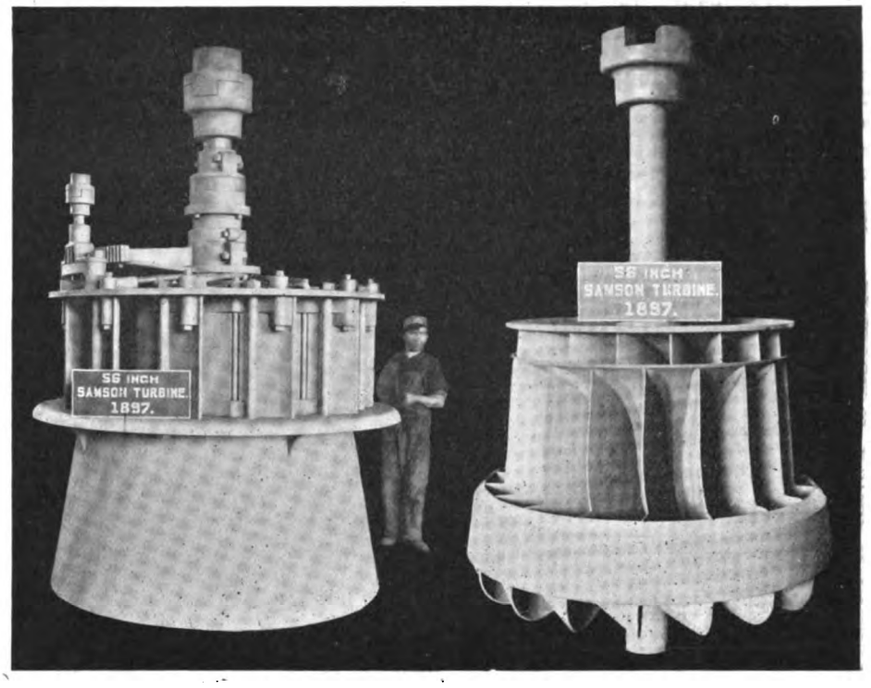
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## WATER WHEELS FOR HIGH PRESSURES.

It is not the purpose of this article to follow the evolution of the turbine and the still more modern jet wheel, from the crude paddle wheel of our ancestors, but rather to illustrate and describe the types of wheels which are now common in the public eye and especially those made by James Leffel and Company, Springfield, Ohio, with notes as to where and how they are made. This firm has been engaged in the manufacture of turbine wheels for thirty-eight years and is still in the forefront of manufacturers of this class of wheels, both as to quantity and perfection of design, as is shown by its Niagara type of wheel. The works are located in the suburbs of Springfield and include a number of large brick buildings conveniently arranged along the lines of two steam railways. The main machine shop is a building 340 feet by 60 feet, and is equipped with heavy iron working tools of almost every description, for it should be remembered that the company provides the complete equipment of a power plant, including the wheels, penstocks, shafting, gears and rope transmission pulleys, and ordinarily employs about 150 hands.

The output embraces three types of the Leffel horizontal and vertical turbine, known as the Standard, Special and Samson, beside the jet type, better known as the cascade or impact wheel, which is especially designed for heads from forty to 2000 feet and upwards, these types embracing over 160 different styles and modifications. Besides the wheels the output includes the Leffel type of engines and stationary and portable boilers.

Fig. 1 illustrates the case and gates of a 56-in. Samson turbine, in which it will be noted that the gates, which are balanced, are placed in the periphery of the case and are made of either bronze or steel, depending upon the service for which they are designed. The gate operating mechanism is also shown, the power being supplied to the small shaft, each individual gate being moved by a rod connecting with a thimble which surrounds the main shaft. In Fig. 2 is shown the design of the runner, or wheel proper, which is mounted within the case. The curves and shape of the buckets or flukes are so designed as to give the greatest economy, having reached 85 per cent. of efficiency at seven-eighths gate.




FIGS. 1 AND 2.—THE CASE AND RUNNER OF A SAMSON TURBINE.

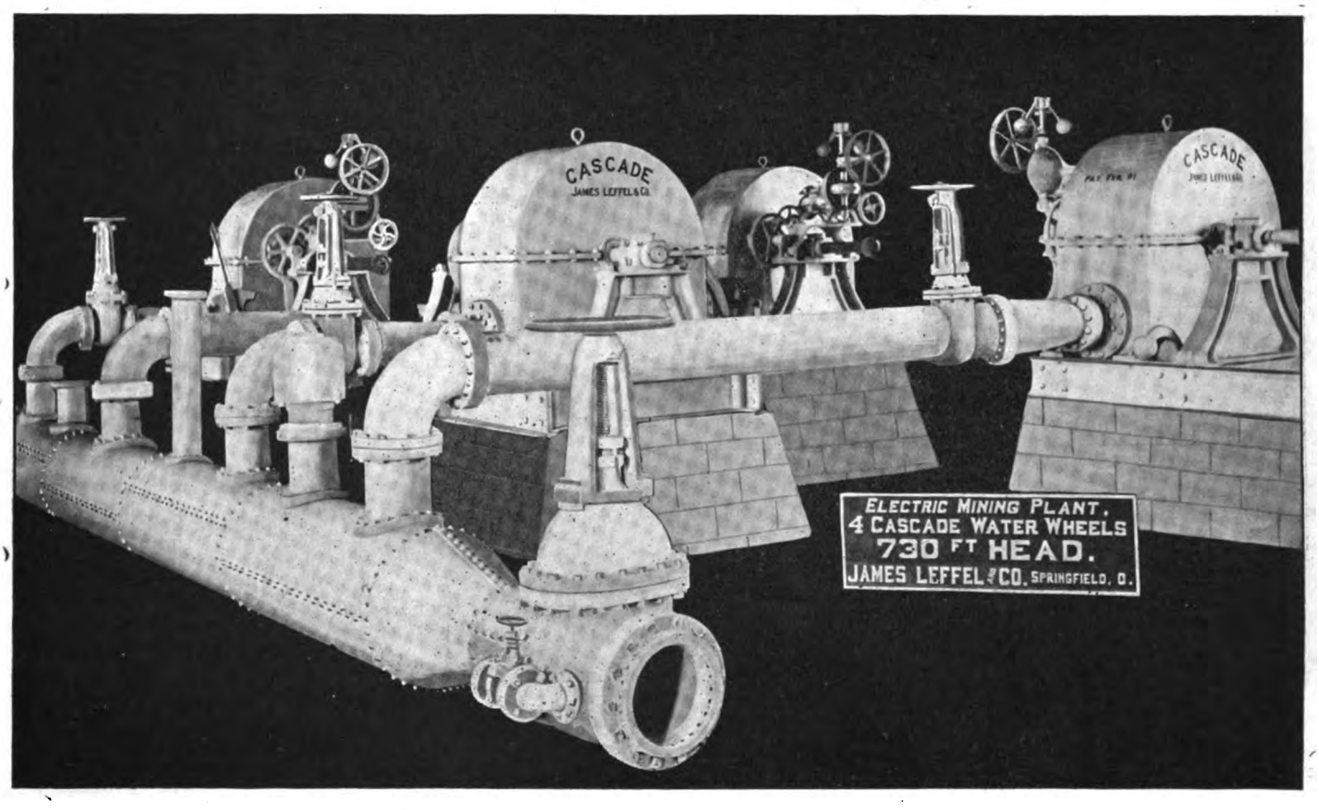



FIG. 3.—A NUMBER OF CASCADE WHEELS COMPLETE WITH PIPING.

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# New Apparatus and Appliances

### JENNEY UNIVERSAL MOTORS.

The accompanying cuts illustrate the new type of motor recently perfected and placed on the market by the Jenney Electric Manufacturing Company, Indianapolis, Ind. On account of the construction of this motor the company has styled it the "Universal" type. Fig. 1 illustrates the motor mounted in the usual manner, with the supporting base on the under side, and with standard pulley on armature shaft. Fig. 2. illustrates the motor bolted to side of post, and with back gear.

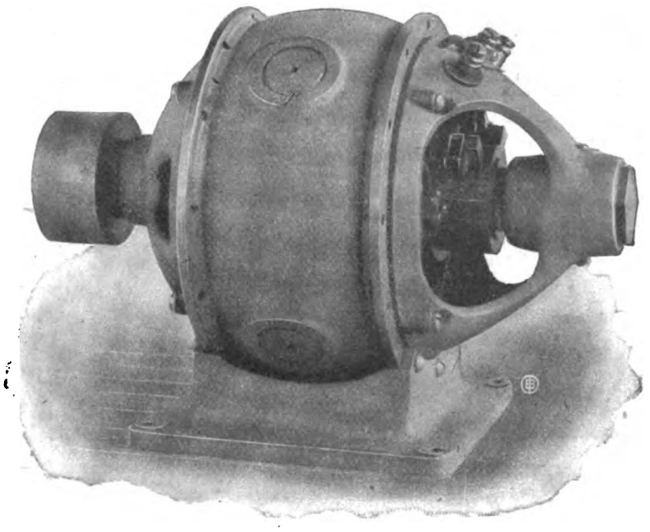


FIG. 1.—BELTED MOTOR UPRIGHT ON BASE.

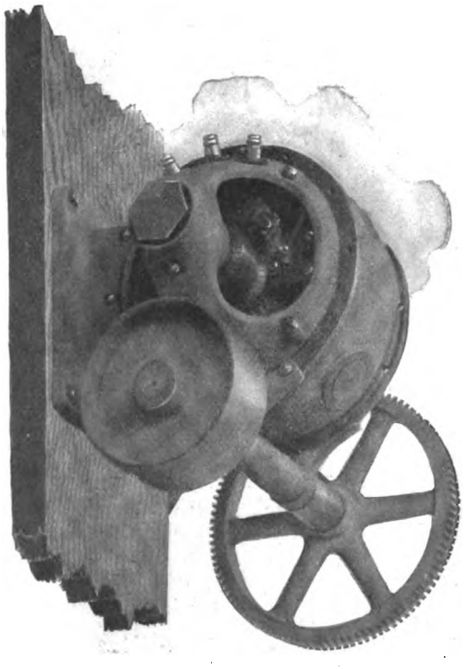


FIG. 2.—GEARED MOTOR WITH BASE IN VERTICAL POSITION.

It will be observed that the frame of the motor is spherical, and provided with two circular bands which are turned true to gauge, and drilled uniformly all around the bands to enable the supporting foot to be attached at various angles, so that the motor can be attached to ceiling or side wall, either right or left handed, and at various other angles. The supporting foot can be made in any special shape desired to enable motor to be coupled to special machinery. The bearings for the back gear are also drilled so that same can be attached to the body of motor frame at any position desired.

The makers claim the great advantage in this arrangement is that a very slow speed can be obtained from the back gear shaft with a comparatively small motor, which results in the cost of outfit being very much less than is the case where a large motor frame is wound to obtain slow speed, and the efficiency of motor is also very much higher.

The back gear enables slow speed to be obtained directly from motor, without the necessity of a countershaft and extra belt, which are expensive as well as troublesome to maintain.

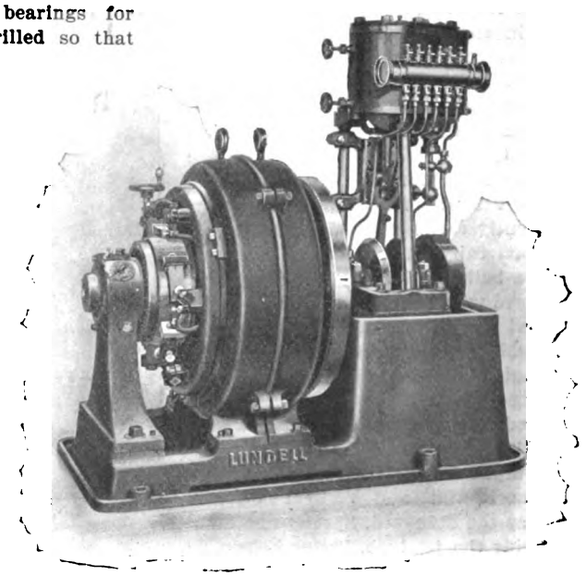
Where motor is to be installed in dirty places and exposed to flying particles, the heads are entirely housed.

These motors are multipolar, having four poles, and are constructed with wrought iron field cores, and the slotted core type of armature. The armature windings are form wound and insulated before being placed on armature. The parts of this machine are interchangeable and the bearings self-oiling, the same high grade of workmanship being maintained throughout as has won for the "Jenney" apparatus such a high reputation.

These machines are now made in sizes from ½ to 5 h. p. inclusive, for both moderate and slow speeds and for all standard voltages, and the company reports that it will soon be in shape to furnish this same type of machine in larger sizes.

### A LUNDELL DIRECT COUPLER GENERATOR.

The illustration shows a Lundell generator driven by direct connection to a Forbes marine type engine. The rating of the generator shown is nominally of 8 kw. capacity, when running at a speed of 500 r. p. m. The set from which this photograph was made has been installed on the steam yacht "Postmaster General," now doing duty in New York Harbor.




A DIRECT COUPLED MARINE TYPE GENERATING SET.

When the plant was installed an exhaustive test was made, which showed that the apparatus is capable of developing 10.8 kw., sufficient to supply 216 lamps. The primary qualities in a direct-connected set for marine work, especially in yachts and similar classes of vessels, are compactness, light weight, ability to stand overloads and accessibility, which are met in this set, of which the total weight is only 1050 lbs., or about 100 lbs. per kw. output. The amount of space taken is small, being 27 in. wide by 6 ft. 2 in. long, the height being 38 in.

The ability of the generator to carry an overload, without sparking at the brushes, is due to the series wound armature and the use of a single field coil, which magnetizes all the different field poles to the same degree of intensity. The magnetic circuit is very short, requiring less copper to energize the field, and thus conduces to high efficiency.

The Sprague Electric Company, New York, is supplying these direct connected types in the following sizes, 8 kw., 16 kw. and 32 kw., generating current for 160, 320 and 640 lamps respectively.

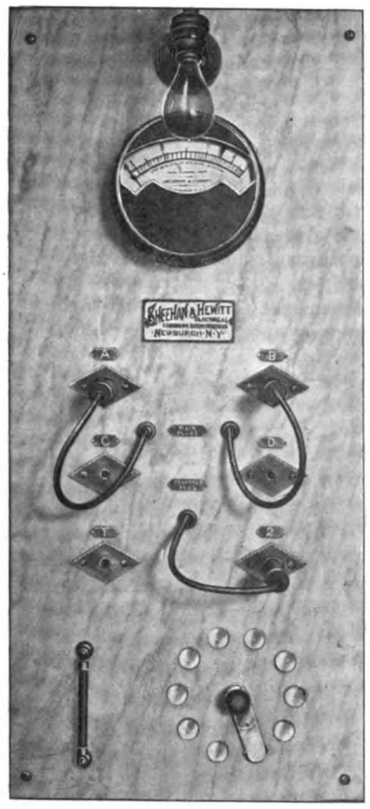
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### A SERIES GOVERNOR BOARD.

A marble switchboard panel fitted for the control of the current to a series circuit of incandescent lamps connected across constant potential mains is shown in the adjoining figure. The peculiarity of this board is the fact that the main steps of the regulation are effected by flexibly connected plugs, of which there

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are three, fitting into six jacks. These are connected with transformers giving various different voltages in such a way that by combinations of the various plug positions and movements of the rotating switch in the lower right-hand corner



A SWITCHBOARD PANEL FOR SERIES INCANDESCENT CIRCUITS.

the circuit can be adjusted in one lamp steps for any number of lamps from one to 40 per cent. overload. The board is also equipped with an enclosed fuse, ammeter and pilot lamp. It is constructed by Sheehan & Hewitt, Newburgh, N. Y.

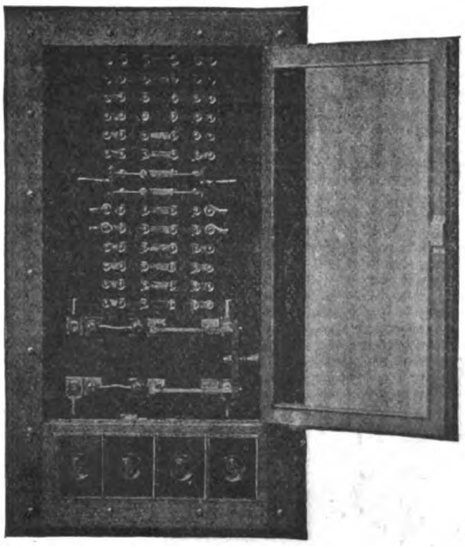
JUNCTION BOXES AND DISTRIBUTION PANELS.

The following illustrations represent the new type of junction box manufactured by Johnson & Morton, Utica, N. Y.

The tablet board containing the fittings of the box is removable and can be placed in the box after all the wiring is installed and after the interior finish of the building is completed, thus preventing any possibility of damage to the finish of the visible parts of the box. The concealed wiring pocket allows the wires to be brought in through the back, top, bottom or sides of the box, as may be most convenient, making the box standard independent of the location of outlets.

All of the branch circuits are supplied with detachable fuse holders, consisting of insulating bars with heavy copper ends, which make sliding contact in substantial jaws. The use of this holder enables the replacing of fuses while current is on the box, without danger of short circuiting or burning. The boxes are all standard width regardless of the number of circuits, and are so designed that they will fit between the uprights in ordinary wooden buildings without any cutting.

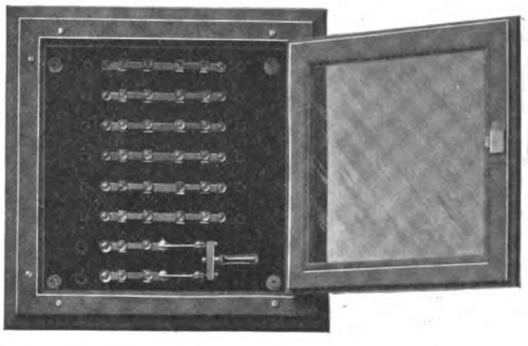
One cut shows a standard box containing a six-circuit tablet board with main



PANEL BOX WITH KNIFE SWITCHES, FUSES AND METER CONNECTIONS.

switch, but with no branch switches. It is intended for use at distributing points when it is desirable to disconnect the circuits supplied from the box and have the switch, fuses and all conducting parts under lock and key.

Another box is made of the same type, but provided with branch circuit knife switches and meter connections. This is intended for use in dwellings and small installations. The service mains are brought to the main fuses and switch, the current passing from here by means of



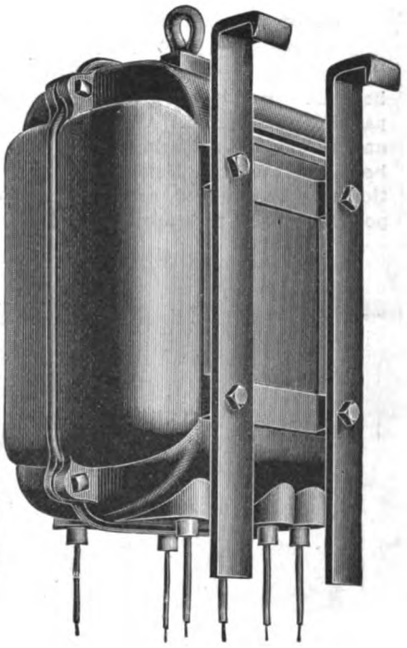
TABLET BOARD WITH ONE MAIN SWITCH.

the meter connections through the meter and back to the bus bars of the box. This complies with the underwriters' requirements for main entrance switch and cut-out, permits the use of a meter and concentrates all parts in the junction box. The branch circuit knife switches permit the disconnecting of any circuit and all parts are under lock and key. The arrangement of the main switch and meter connection can be supplied with any of the boxes whether they have branch switches or not.

The other cut shows a standard box adapted for use in public buildings of medium size, such as school houses using commercial power. It contains main switch with fuses and connections for the meter, and two knife switches, each controlling three branch circuits supplying different sections of the building, also four branch circuit flush switches for controling circuits in the immediate vicinity of the box. The main switch and section switches can not be tampered with when the door is locked, but the panel of the door being of glass can be easily broken in case of an emergency when it is necessary to shut off the current. This arrangement combines a distributing board and junction box in a most convenient and economical manner.

MOLONEY TYPE A TRANSFORMERS.

Working on the general principle that perfection in one line is attainable only by excluding all other lines, the Moloney Electric Company of St. Louis, Mo., devotes its efforts exclusively to the construction of its type A transformers. The instrument is of the core type, with a cover divided in a vertical plane, as the illustration shows, and without an interior terminal plate; the change of connections to obtain 50 or 100 volts secondary or 1000 or 2000 volts primary being effected outside the case. It is modestly rated so that it can stand an overload of 25 per cent. The cores are compressed under a very high pressure and the wind-

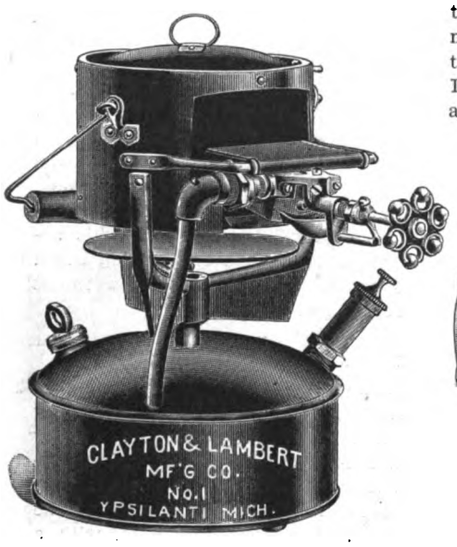


VIEW OF TRANSFORMER, SHOWING HANGER.

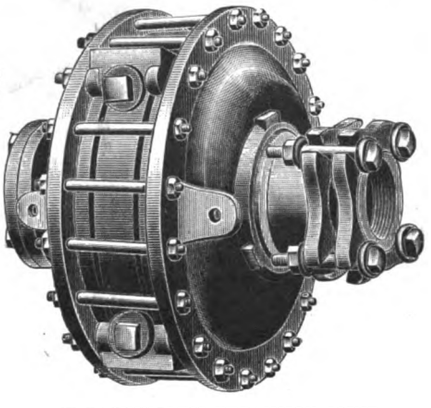
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ing put on under an unusually high tension in order to eliminate any vibration of the parts with the alternating magnetism which might eventually fray the insulation.

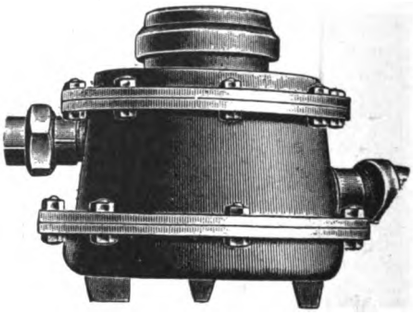
The transformer is mounted on a simple hanger, readily attachable to cross arms or cleats and with each transformer order the company gives a pair of single pole non-arcing fuse blocks, having outside connections. The company also encourages the testing of transformers by consumers, and to assist this has published a pamphlet of instructions which it will be pleased to send to those interested.




A CONVENIENT FIRE POT OR TORCH.



THE PACKINGLESS EXPANSION JOINT.



THE STEAM METER.

### A CONVERTIBLE FIRE POT AND TORCH.

A fire pot for which the claim is made that it will work satisfactorily in the heaviest wind is shown in the accompanying illustration. A kettle of solder and a pair of soldering irons can be heated at the same time, or the top section may be removed, converting the fire pot into a torch or brazing fire. The burner hangs on a swivel, so that it may be turned in any direction desired, and has a cast generator. It is made by the Clayton and Lambert Manufacturing Company, Ypsilanti, Mich.

### THE DISTRIBUTION OF EXHAUST STEAM FOR HEATING PURPOSES.

The development and utilization of by-products in many manufacturing lines have often quite revolutionized the industries, owing to fact that the by-products have often proven nearly as valuable, and in some cases more valuable, than the main product.

Central station work is fundamentally the manufacture of one form of energy, electric power, from another, fuel, the processes through which the energy passes giving several by-products. The greatest and most valuable of these is the heat usually thrown away in the exhaust steam from the engines. It is well known that the average engine only transforms into mechanical power about 10 per cent. of the energy given to the steam by the coal. The other 90 per cent., as a rule, is thrown away in the exhaust, while near the central station may be many low pressure steam heating plants with their uneconomical boilers and high cost of attendance generating what is thrown away at the station.

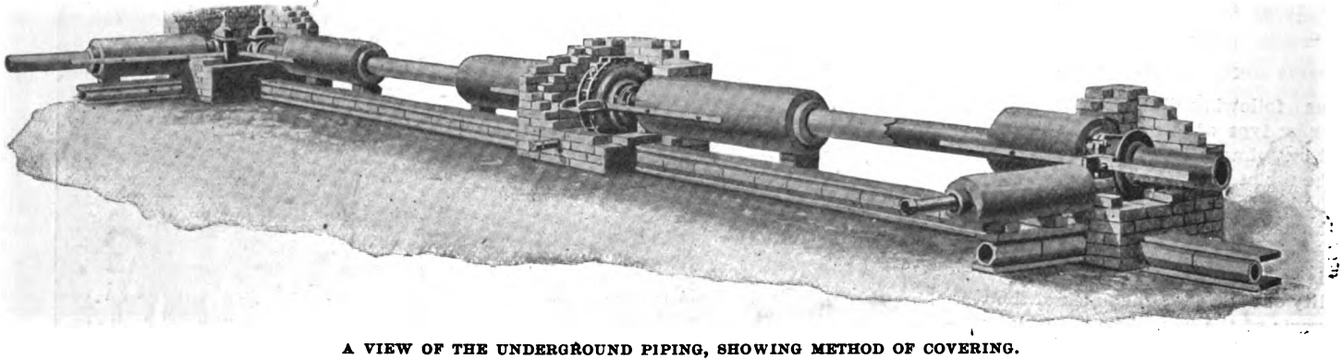
In condensing plants a slightly higher percentage, five to ten, of the heat energy in the steam is converted into mechanical work, but when the exhaust steam at or near atmospheric pressure can be sold for anything like the value of the equivalent fuel the loss due to non-condensing is many times refunded.

The American District Steam Company, Lockport, New York, has worked for years on the system designed by Mr. Birdsill Holly and has brought to great perfection the details by which the troubles of underground steam distribution are overcome. These troubles are condensation, leakage and expansion and contraction.

The system consists fundamentally of lap-welded wrought iron pipe, surounded by a 1-in. air space in bored white pine logs, lined with tin and coated with asphaltum, sometimes being further covered with 3-ply tar roofing felt. At intervals and especially where services are taken off, these pipes are coupled through special expansion joints with no sliding contacts, the expansion being taken up in flexible diaphragms so that no manholes are necessary to allow the packing to be attended to. The lines are laid with special care for drainage and have a tile drain pipe below them to carry off the drips.

The services are led through special reducing valves by which the pressure in the house system may be kept constant and also through meters ingeniously designed by Mr. Holly, wherein the steam impringes upon blades like those of anemometers, the speed being controlled by blades or fans in water to act as a brake. From such a meter the steam passes to direct radiators and from them to a cooling coil, over which cold air enters the house to give indirect radiation and ventilation. This extracts practically the last vestiges of heat from the condensed water, which is then trapped to the sewer.

In a paper presented by Dr. M. M. Fenner before the last annual convention of the New York State Street Railway Association the results of the application of this system at the power station of the Dunkirk & Fredonia Railroad were given. Six per cent. dividends were paid, of which 3 per cent. came from the sale of exhaust steam, the steam being sold at a rate based upon the cost of equivalent fuel at $4 per ton of anthracite, or at a flat rate of $3 per 1000 cu. ft of space heated. Figuring roughly that the exhaust steam per h. p. continuous would heat



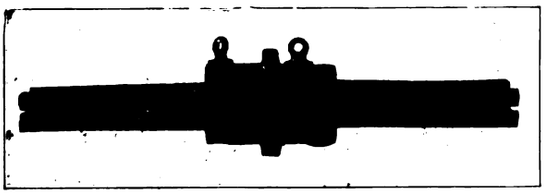
A VIEW OF THE UNDERGROUND PIPING, SHOWING METHOD OF COVERING.

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10,000 cu. ft. of space in average buildings, this amounts to an income of about $30 per h. p. per season.

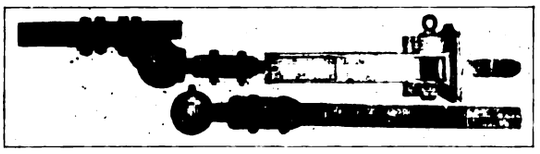
THE VAN DORN AUTOMATIC COUPLERS.

Following the lead of steam railroads, which have long ago discarded pin and link couplers for the passenger service, the street railways are rapidly adopting



DRAWBAR HEADS OF THE VAN DORN COUPLER.

automatic coupling. The accompanying illustrations show devices of this nature made by the W. T. Van Dorn Company, Chicago, Ill. The first figure shows two of the draw bar heads closely coupled together, in which is clearly shown the two pin holes to each head by which the wear is distributed. The coupling bar is a separate piece and can be placed in either of the draw bar heads, so that when forced into the opposite head the springs therein will yield sufficiently to allow the hook to



COUPLER WITH BALL JOINT ATTACHMENT.

pass around the pin and fasten it. Each head has two or more springs constructed so as to do away with any liability of danger when coupled to any other class of couplers or the ordinary link.

The other illustration shows a coupling connected to the Van Dorn improved ball joint attachment, giving perfect flexibility in all directions and a ready means of adjusting the length. The ball of the joint is fitted with a pin so that the coupler cannot turn over. These couplings are made in ten sizes and styles adapted for surface, elevated, mining, dump or any other standard style of cars.

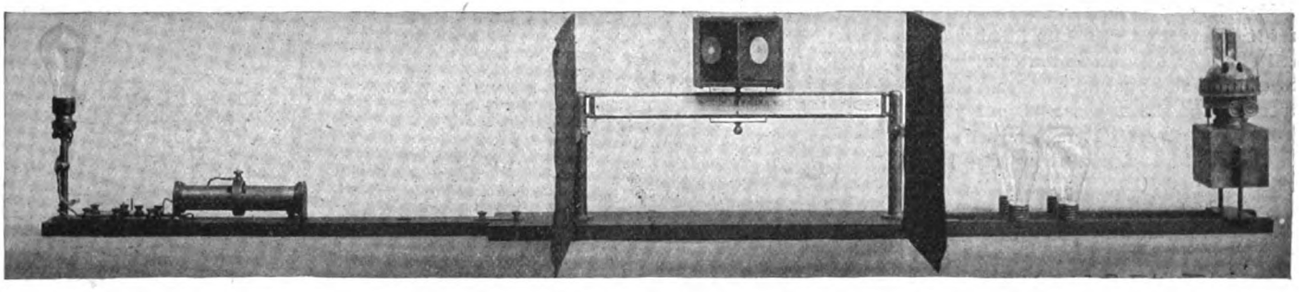
A PORTABLE PHOTOMETER FOR CENTRAL STATIONS AND LAMP SALESMEN.

Now that lamp buyers have become too critical to accept any incandescent lamp as having the candle power, voltage and efficiency marked on its label, the need of a means of testing is imperative. In the last issue of the American Electrician directions were given for the construction of a photometer, resembling closely that described below. The instrument complete is put on the market by the Electric Motor & Equipment Company, Newark, N. J., successor to the Newark Ornamental Iron & Sign Works, the well known makers of electrically illuminated signs.

The photometer is a knock-down instrument, 5 ft. in length when extended and capable of being packed into a space 24 ins. long by 6 ins. wide and 9 ins. high, and is made up in two styles, one for central station use and the other for salesmen, the former being somewhat stronger and the latter lighter.

The working standard of light is a duplex oil lamp, which is calibrated by the simple use of a primary standard placed in the socket in which the lamps are tested. These primary standards are special lamps made by the General Electric Lamp Works, seasoned and of low efficiency, and hence undergo very slow changes. By using one of these for a moment or two the oil lamp can be adjusted to the proper brilliancy at which it will run for hours without re-calibration.

The spot box is of the regular Bunsen grease spot type, with inclined mirrors and working over a celluloid scale. A small German silver resistance coil provides suitable means for adjusting the voltage over a range of about 15 per cent. Owing to the fact that the influence of extraneous light is more or less balanced out by the calibration of the working standard against the primary standard, placed in the position which the lamps to be tested subsequently occupy, no specially prepared dark room is necessary. The weight of the portable instrument is reduced to 12 pounds, complete in a canvas carrying case.

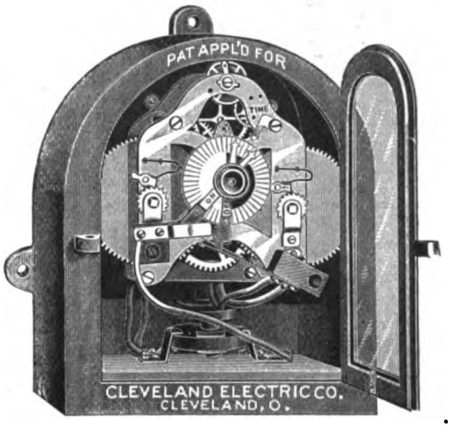


A PORTABLE PHOTOMETER.

THE CLEVELAND AUTOMATIC TIME SWITCH.

The value of a reliable switch for turning on and off lights at predetermined times, particularly for use on street lamp posts worked from constant potenial circuits carrying commercial loads, is self-evident.

A new switch of this type is that shown in the accompanying illustration and made by the Cleveland Electric Company, Cleveland, Ohio. It consists primarily of an 8-day Seth Thomas clock, fitted with a 24-hour stem on which is centered a time dial and two independent pointers. The contact of one of these with an appropriate piece closes the circuit through a solenoid, which operates the switch, the movement of its armature immediately breaking the circuit with the pointer by moving the piece with which it makes contact. The same motion places in position the appropriate contact for the other pointer, which in turn is removed and the




AN AUTOMATIC TIME SWITCH.

circuit broken as soon as the reverse operation of the main switch is made.

The Cleveland Electric Company also makes a high tension series arc cut out. The affairs of the company are under the management of Mr. Edwin M. Smith, a novice in the electrical field, but with an inclination to enlarge the circle of his acquaintances.

A COMBINED MAXIMUM DEMAND AND INTEGRATING METER.

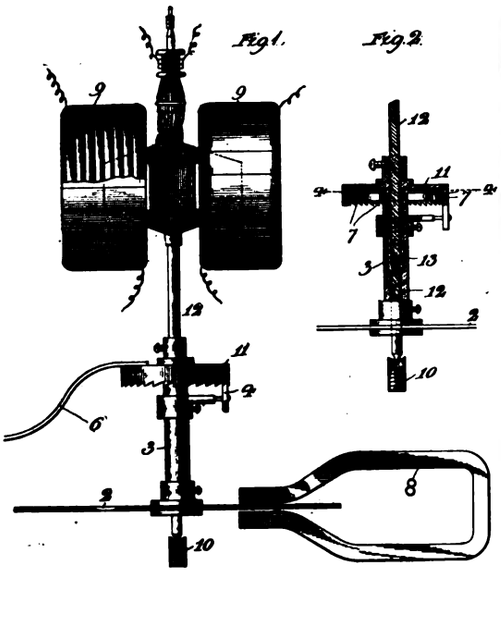
The great interest taken among central stations in discount systems based upon the ratio of the average to the maximum demand has brought out several instruments for indicating the maximum current used on circuits, in addition to the usual integrating meter for showing the average demand. A device for combining the two indications in one instrument is shown in the accompanying drawings; a meter built on this principle being

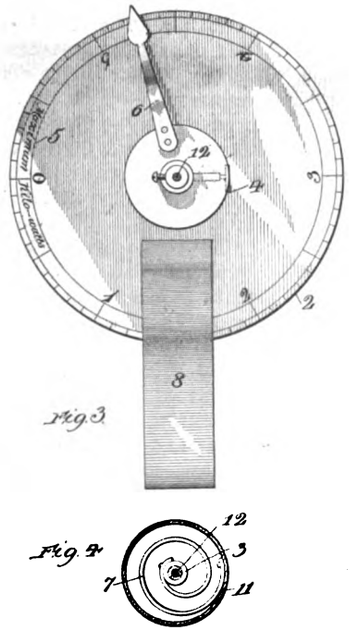
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shown complete in the half-tone illustration.

The upper or motor part of the shaft of the meter drives the lower or dragging disc part through a spiral spring 7, which is shown separately in Fig. 4. The deflection of this spring is proportional to the drag of the motor upon the brake disc and consequently to the load drawn through the meter. Fixed to the upper shaft is a fine ratchet, 11, and on the lower shaft is a pawl engaging therewith so that the spring once deflected cannot restore itself; thus the maximum load upon the meter will cause a maximum deflection of the spring, which will remain until the pawl is released from the ratchet by hand. This reflection will be indicated by the pointer, 6, upon a scale on the edge of the brake disc, which is clearly shown in the photographic reproduction.

To prevent sudden brief overloads from recording themselves the lower end, 13, see Fig. 2, of the upper section of the shaft is seated in a deep cup filled with a small quantity of viscous material which acts as a brake against sudden relative movements of the two shafts, but yields to continued stress. It is interesting to note that in this material there is so little friction of rest that the indicator will move with less torque than that required to revolve the disc. The increase in weight of the revolving parts in the case of a Thomson meter is only about 4 per cent. The instrument is the design of Mr. Edward S. Halsey, 139 Adams Street, Chcago.




DETAILS OF A COMBINED INTEGRATING AND MAXIMUM RECORDING METER.

### AN ELECTRIC GAS LIGHTER.

Among the many inventions for lighting gas by electricity, the most used is the valve pendant burner, of which there are quite a number on the market, among them the Jypco, a cut of which is here shown.

This burner is made out of one solid piece of brass, with a spiral spring electrode attached to burner arm, making it easy of operation. The special feature of this burner is the pull back spring, which unlike spiral springs, exerts no tilting strain on the valve; also the arrangement used for preventing short circuits, which not only makes the burner ground proof, but prevents leakage of gas resulting from any accident that may happen to the burner.

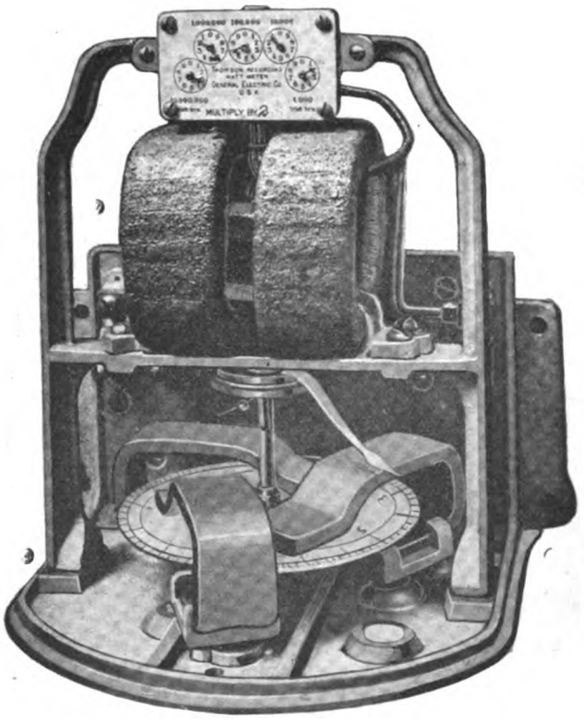
It is manufactured by Messrs. John Y. Parke & Co., Philadelphia, who also make all kinds of common, acetylene and incandescent gas lighting appliances.




A PENDANT GAS LIGHTER.

### THE OTIS FEED WATER HEATER.

A surface heater and purifier of the tubular type in which the exhaust steam passes through the tubes and the feed water circulates around them is shown in partial section in the accompanying illustration, which clearly illustrates the arrangement of the parts. The exhaust enters at the top and passes downward to a chamber at the bottom of the heater exposed to cold feed water, where the water and oil remain owing to their weight and are thereby removed from the steam which, after it is condensed, can be used for boiler feeding without danger of introducing oil. The heater is made by the Stewart Heater Company, Buffalo, N. Y.



MAXIMUM RECORDING DEVICE COMBINED WITH THOMSON WATTMETER.




A SURFACE FEED WATER HEATER.

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A PORTABLE CABLE TESTING OUTFIT.

The firm of Queen & Co., Inc., Philadelphia, has placed on the market a new portable cable testing outfit which is a decided departure from anything heretofore produced, and is so constructed as to facilitate in every possible way the usual measurements on cables. The complete outfit comprises a testing case, galvonometer, tripod, extra system, camp stool and heavy leather carrying case, which contains everything when packed.

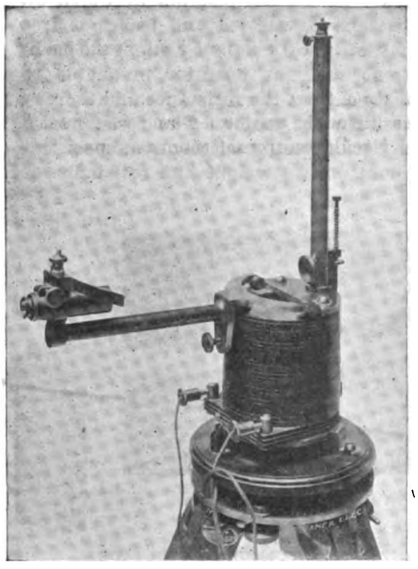


FIG. 2.—GALVANOMETER ON TRIPOD.

The galvanometer illustrated in Fig. 2 is of the well known Queen pattern fitted, as shown, with telescope and scale. As will be noticed, the telescope arm and scale are very short, thereby rendering it compact and stable. The scale is a photographic one and, although less than five inches long, is so finely graduated and highly magnified as to permit of as accurate reading of the deflection as with the usual meter scale and long distance. The galvonometer is held on to the tripod by a spring screw, which while securely supporting it, permits it to be easily and quickly leveled. Leveling screws and a sensitive level assist in its rapid adjustment. All necessary adjustments are supplied on telescope and scale. The tripod is one of the transit tripods, which when closed is very short, yet when open, perfectly solid.

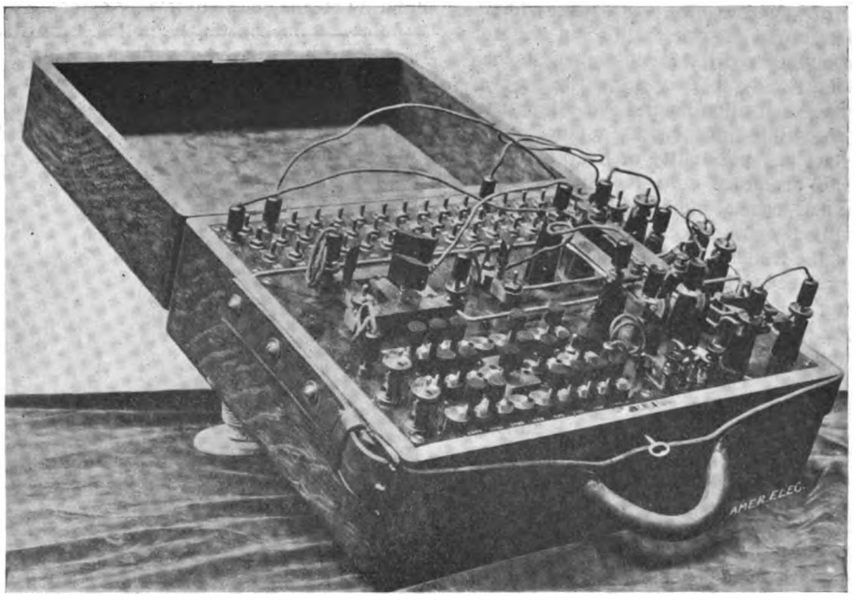


FIG. 3.—THE TESTING CASE.

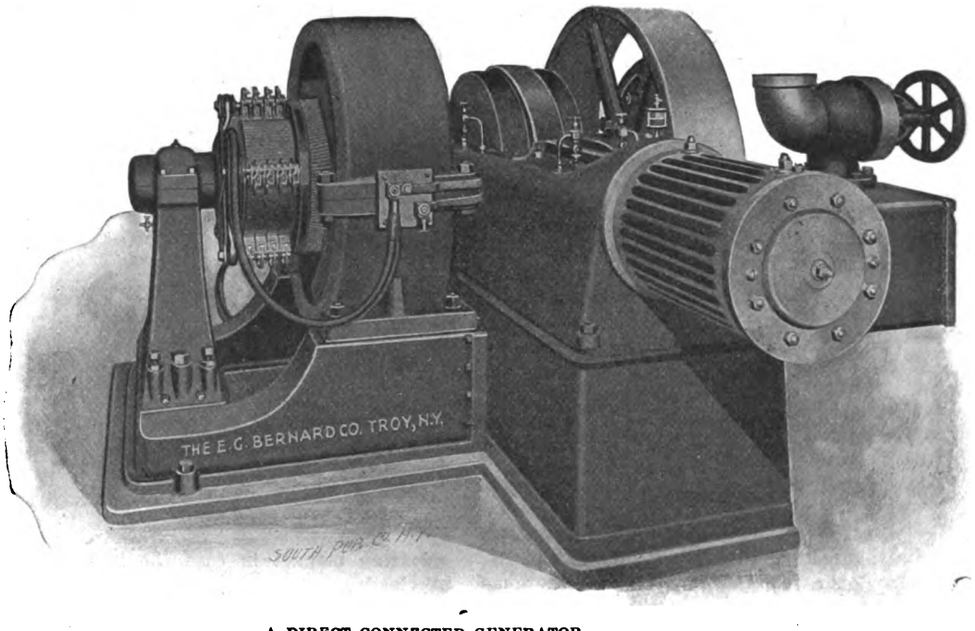
The testing case is illustrated in Fig. 3. It contains everything for making Wheatstone bridge resistance measurements, direct deflection insulation measurements, capacity tests, and the Varley and Murray loop tests; also if desired insulation measurements by loss of charge.

High insulation is secured throughout by means of polished and corrugated hard rubber pillars. All connections are in sight and made by means of copper rods run clear of everything. For any test requiring high insulation there is no low insulation point permitting leakage. For example, when the Wheatstone bridge is not in use it is entirely cut out by means of a switch, thereby not vitiating the capacity or insulation tests.

The insulation of all contacts under the rubber base is kept high by running the hard rubber pillars clear through and corrugating below as well as above the rubber plate. The galvanometer when used ballistically gives deflections strictly proportional to the discharge. When used for direct deflection measurements the deflections are strictly proportional to the current and it is thoroughly dead-beat.



FIG. 1.—THE SET IN USE.




A DIRECT CONNECTED GENERATOR.

DIRECT-CONNECTED MULTIPOLAR GENERATOR.

The direct-connected generator shown in the accompanying engraving is designed for high electrical efficiency with-

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out sacrifice of any of the properties upon which the smooth running of the machine under practical conditions are dependent. The mechanical features have received special consideration, the commutator being of generous size, the brushes having a large area of contact and the armature thoroughly ventilated through both longitudinal and radial openings. The bearings are self-aligning and self-oiling, easily accessible and of such a length as to obviate any possibility of heating.

The armature core is constructed of discs of special non-hysteric iron thoroughly tested and carefully annealed. It is of the ironclad type, the conductors being imbedded below the surface in insulating tubes made up of mica and oiled paper. The coils are machine wound, absolutely symmetrical and so aranged that no conductors cross having betwen them a high difference of potential. The commutator is also ventilated and is fully 20 per cent. larger than the commutator on usual types of similar machines of the same size. The brush holder is of the reaction type and the brushes adjust themselves to a bearing with minimum friction, while at the same time they are kept in perfect contact with the holder. A brush can be easily replaced in five to ten seconds while the machine is in operation. The brush contact area is based on about 25 amperes per square inch of carbon brush, this being from 20 to 40 per cent. more than is the usual practice. The result of the care taken in the design and selection of materials is a machine of slow speed and high efficiency, that will run sparkless and perfectly cool under normal load, require a minimum of attendance and withstand a more considerable overload than is usual with machines of the same efficiency. The manufacturer of the direct-connected generator described is the E. G. Bernard Company, Troy, N. Y.

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### MOTOR CONTROLLERS.

In the early use of electric motors for power distribution the motor itself was simply called upon to revolve and give power at a fixed speed. The adaptation of this power to the machines driven was effected by belts, cone pulleys, friction clutches, etc. Now that motors are direct coupled or direct geared to machines the speed or torque control, starting, stopping, etc., must be arranged for in the electric circuits instead of in the mechanical connections. Different types of machines involve different requirements, necessitating a large number of different controllers. Of these the Cutler-Hammer Manufacturing Company of Chicago, Ill., makes a remarkably complete line, some of the newest instruments of which are illustrated herewith.

Fig. 1 shows what is called a compound controller for large printing presses. The rheostat arm is fitted for controlling the speed of the motor by three different methods. In starting it first cuts out the armature resistance, then cuts out the series coils of the motor field and finally inserts resistance in the shunt field circuit. Below this rotating arm on the controller is the main switch, consisting of a horizontal arm pivoted at its center, the two ends constituting the two knives of a double pole switch. This is closed by hand by means of the upwardly extending handle and is constantly pulled toward the open position by coiled springs.

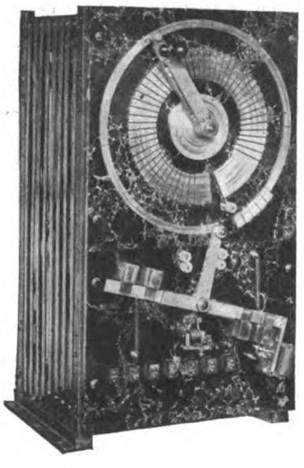


FIG. 1.—A PRINTING PRESS CONTROLLER.

When closed it is latched by the armature of a small magnet connected up with a number of switch buttons and contacts arranged to be automatically closed by broken paper or other mishap. The operation of this magnet releases the arm which is pulled into the open position by the springs. A small overload magnet also acts as a relay to operate the same releasing magnet in case the motor is overloaded.

Fig. 2 shows what is termed a reversible controller, which is designed for cranes or hoists, and consists of a long arm linked with a four-arm dial switch, which serves in the usual way to reverse the armature connections. Pinned to the end of one of these four arms is a connecting rod which serves to push upwardly a crosshead carrying carbon contacts on the rheostat connections at the top of the controller. The connecting rod is slotted so that the rotating switch arm can only push the crosshead up, but cannot pull it down. It falls by gravity and its speed is controlled by a dash pot. When, therefore, the controller is reversed it pushes the crosshead up quickly to the top position in which all resistance is inserted and leaves it free to fall of its own weight against the dashpot, so that the operator is unable to quickly cut out the resistance and thereby overstrain the motor. The resistance is thus cut out automatically at a speed dependent on the weight and resistance of the dash pot, starting the motor smoothly at the proper rate of acceleration.

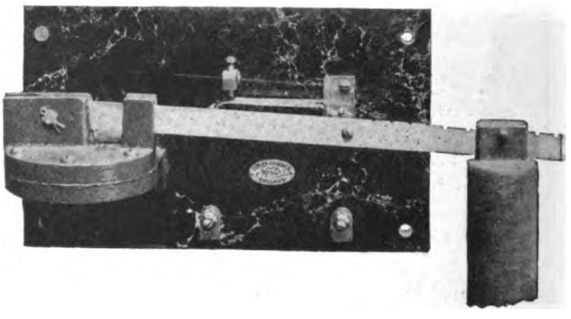


FIG. 4.—AN AUTOMATIC PRESSURE REGULATOR.

Fig. 3 shows an ingenious instrument applicable to many various uses and termed a self starter. It consists of a solenoid designed to attract a vertical plunger, which is connected with an L-shaped pivoted casting. The two arms of the L constitute the two poles of a double pole main switch with laminated copper contacts and secondary or following breaks of carbon. This is operated with a quick snap whenever the circuit of the solenoid coil is made or broken. The armature of the solenoid is also connected through a coiled spring with a crosshead at the bottom of the controller, carrying the contacts on the rheostat segments. When the armature rises suddenly, closing the main switch described above, it compresses this spring, which gradually

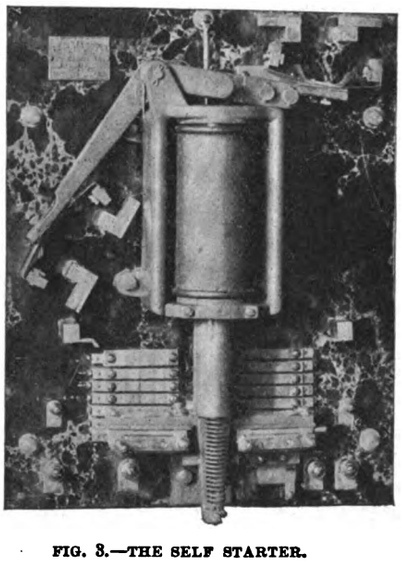


FIG. 3.—THE SELF STARTER.

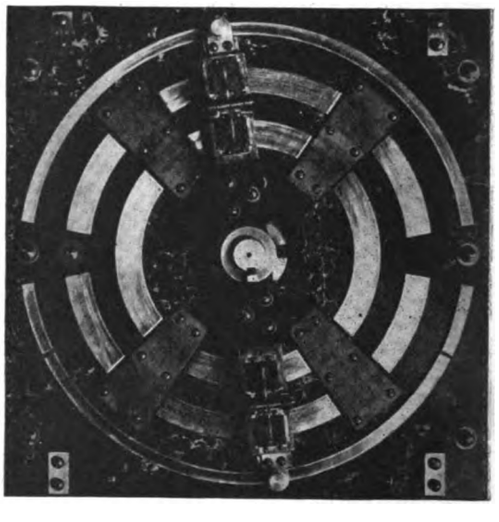


FIG. 5.—A REVERSING SWITCH FOR ELEVATORS

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forces up the rheostat crosshead, which is fitted with a retarding device so that the resistance cannot be cut out too rapidly. The circuit of the solenoid windings is necessarily closed while the motor is running, but the moving parts are fitted with contacts whereby—when the armature has risen and the magnetism need only be maintained at sufficient strength to hold

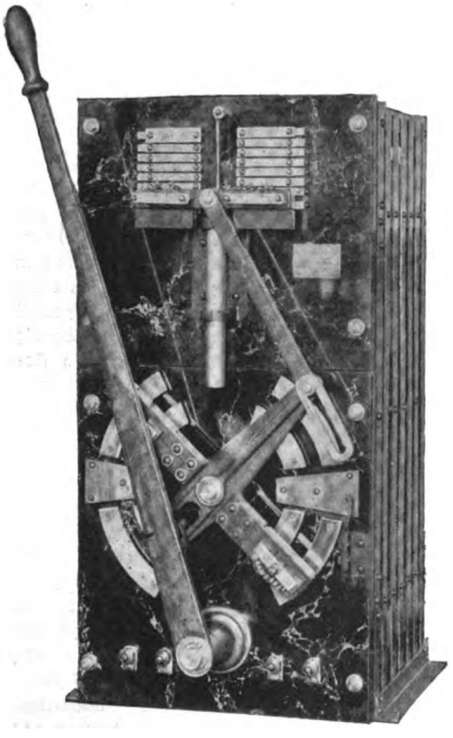


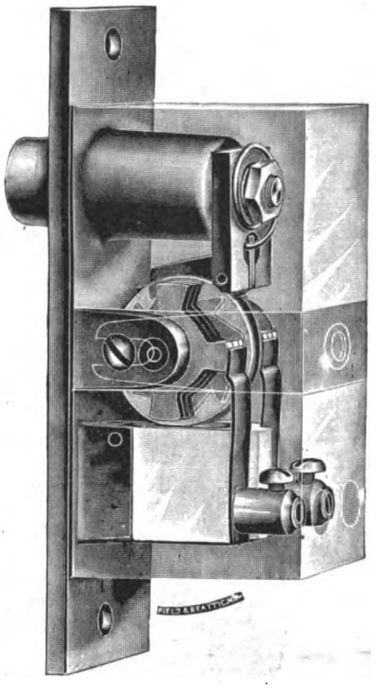
FIG. 2.—A REVERSIBLE CONTROLLER.

it in the upper position—the current is greatly reduced, thus cutting down the waste of energy to a negligible quantity.

This instrument is applicable to elevators, motor driven pumps or other apparatus where it is desirable to start and stop a motor automatically. For pump service it may be combined with any float switch whose contacts need only control the small current taken by the solenoid windings, instead of the main current of the motor. For motors used in obtaining a constant pressure, either hydraulic or pneumatic, the pressure regulator shown in Fig. 4 may be used on the same self starter. This consists of a diaphragm forcing upwardly a weighted lever and operating a small snap switch on the circuit of the solenoid of the self starter. For elevator service the same self starter may be used with a reversing switch, such as is shown in Fig. 5. Here the two inner rings operate to reverse the armature connections in the ordinary way, while the outer rings send current to the solenoid of the self starter when the reversing switch is in either the up or down running position.

### A NOVEL DOOR SWITCH.

A switch designed for turning on the lights of telephone booths, toilets, etc., when occupied, and turning them off when unoccupied, whether the door is open or closed, invented by Mr. A. Lüngen, is shown in an adjoining figure, and is made by Edwards & Company, New York City. It is called the Eco Door Switch, and is the first electric light fitting which this firm, well known through its electrical house goods, has manufactured. The object of the switch is to turn on the light when the door is opened and closed



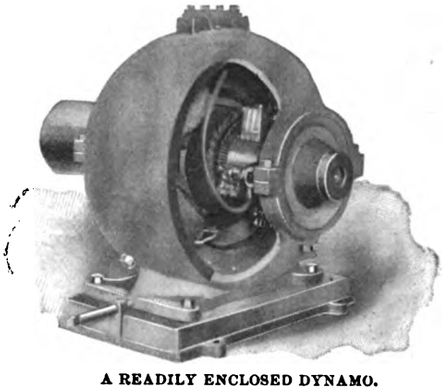
AN AUTOMATIC DOOR SWITCH.

and turn it off again the next time the door is opened and closed, so that the light will be left on when a person enters the apartment in which it is placed, and turned off again when the apartment is vacated. It differs in this respect from previous door switches, which, as is well known, are arranged to turn the light on when the door is closed and turn it off when the door is open, wasting considerable current if the door is closed with no one inside. The new switch is provided with porcelain insulation and a porcelain cover, and has been approved by the National Board of Fire Underwriters. Its size is such that it can be used on any door frame.

### A LINE OF SPHERICAL OPEN OR ENCLOSED DYNAMOS AND MOTORS.

In modern dynamo design small machines are built so that by the addition of covers over the openings, the same machines can be converted from the open to the enclosed type, with the appropriate reduction of rating to prevent overheating in the unventilated condition necessitated by the enclosure. Such a machine is made by Roth Bros. & Company, Chicago, Ill., possessing several ingenious details described below and is illustrated herewith.

The frame or magnet yoke is of cast-iron and is cast integral with four extensions or arms to hold the bearings, which are of a peculiar design, sufficiently large to permit the removal of the armature endwise through the openings they leave when removed from the encircling arms. The yoke is not split, but the arms are, in order that they may be clamped tightly on the bearings, which may be rotated



A READILY ENCLOSED DYNAMO.

to bring the oiling wells in the proper position, whether the machine is run on the floor, ceiling or wall. The magnet poles are of soft cast-steel, bolted to the yoke, and fitted with pole shoes to reduce the density at the air gap.

### AN AUTOMATIC ADJUSTABLE ELECTROLIER.

An illustration appearing on this page shows an automatic supporting electrolier for the adjustment of incandescent electric lights to various heights. It is of the spring balance type, composed of a porcelain base upon which are mounted two



AN AUTOMATIC ELECTROLIER.

standards supporting a drum upon which the cord is wound, the cord being electrically connected to each pole of the drum. Each standard is connected by a fuse to the main contact pieces, thereby taking the place of the fuse rosette in common use. Two hooks are provided to make contact with line wires for outside or moulding wiring. There are also two holes in the porcelain base to bring

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through the wires for concealed wiring, the whole being enclosed in a brass shell (made in four different finishes, silver striped, bronze striped, brass striped and polished brass). The action is the same as that of the common spring balance curtain. It has no unsightly loops of cord or balls to swing light after being adjusted.

---

"DIAMOND H" PUSH BUTTON SWITCHES.

It would seem that the demand for push button switches has been more than satisfied by the various types upon the market, and that very little improvement could be made in switches of this class. The "Diamond H." line of push button switches has many points of merit which will commend themselves to all who examine it much more forcibly than can be done by a written description.

Fig. 1 shows the switch as a whole with a solid brass face plate. The ears for attaching the switch to the wall or woodwork are recessed in the back of the face plate, avoiding the necessity of cutting a recess in the wall for them. Fig. 2 is a 10 ampere double pole switch with face plate removed. The mechanism and contacts are enclosed in a porcelain base, shown with the front side cut away. The switch plates, one of which is shown in the cut, are of the knife pattern, and owing to the device for driving same into and out of the contact clips, a high velocity and consequently a short arc are assured. The contact, Fig. 3, is of phosphor bronze attached to a brass upright, which carries the binding screw. The phosphor bronze clip is comparatively long and wide, which insures flexibility and firm pressure upon the end of the switch plate. The spring, Fig. 4, is a simple coiled spring of comparatively large diameter made of steel music wire, with upturned ends to engage the moving parts of the switch.

The insulation of the current carrying parts is effected by spools made of sheet mica, laminated, and held together by a central bushing. This spool is shown in section in Fig. 5. It is loosely mounted in an elongated opening in the switch plate, and is driven by a pin through its central opening. The body of the spool is surrounded by a steel sleeve, thus preventing the edges of the opening in the switch plate from cutting the mica. The movement of the buttons is smooth and the pressure required is uniform throughout their travel and nothing else has been sacrificed to secure this end. Details of less importance than those referred to have been carefully considered and the result is a switch which the manufacturer, the Hart Manufacturing Company, Hartford, Conn., believes to be thoroughly good and reliable.



FIG. 4.

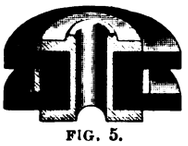


FIG. 5.

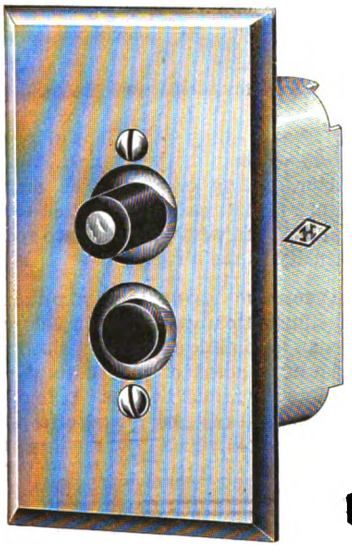


FIG 1.



FIG. 3.

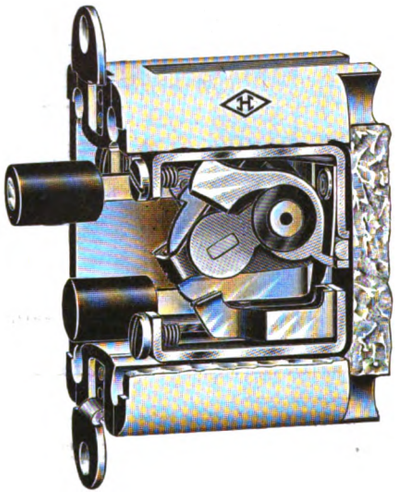


FIG. 2.

## NEW BOOKS.

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Liquid Air and the Liquefaction of Gases, by T. O'Conor Sloane, New York. Norman W. Henley & Co. 365 pages. Illustrated. Price $2.50.

The appearance of this new work is most timely, the greatest interest having been excited within the last few months in this subject, about which little is known and less published. The treatment of the subject consists largely of historical accounts of the developments made by the different workers in the field, such as Michael Faraday, Raoul Pictet, Louis-Paul Cailletet, Jas. Dewar, Chas. E. Tripler and others, prefaced by four chapters intended to give the lay reader a good ground work of the fundamental laws of physics, heat and gases that apply to the subject of the book. Following the historical section are three chapters describing most clearly the various methods of obtaining liquefied air, the description being illuminated and rendered remarkably intelligible by ample illustrations. Another chapter which is as fascinating as a work of fiction is that on experiments with liquid air and still another that is largely speculative and prophetic is entitled "Some of the Applications of Low Temperatures."

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American Electrical Cases, edited by Wm. W. Morrill. Albany, N. Y. Matthew Bender. Six volumes. Price $6 per volume, $36 for the set

This elaborate work comprises a collection of all the important cases, excepting patent litigation, in the State and Federal courts from 1873 to 1897, on subjects relating to the telegraph, the telephone, electric light and power, electric railway and other uses of electricity. There is perhaps no other single work which contains as much of value for use in the legal departments of electric and street railway companies. It contains full reports of between two thousand and three thousand cases, among them actions treating of the powers of municipal corporations over the streets and highways, the rights of the municipalities to impose license fees, the rights of abutting property owners, the cutting of trees, the rights of the telegraph along the steam railroad, the crossing of electrical and steam railroads, the interference of different companies in the use of the same streets, the various phases of negligence, such as injuries to employees or others by electric shock or otherwise, the duties of street railway companies to passengers and to others using the street, the taxation of companies and their property, the rights of municipalities to supply electric light, the negligence of telegraph companies in sending messages, etc., etc. A work of this sort not only gives valuable information upon specific questions of law, but is invaluable as a reference work, as figures obtained from it show the general tendency of the law and serve in this way for the preparation of arguments.

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Steam Engine Indicator. By F. R. Low. New York: The Power Publishing Company. 203 pages, illustrated. Price $1.50.

With the increasing use of direct connected electric lighting sets of larger and larger sizes there arises a greater need of accurate cylinder indication to give any idea of the mechanical input of the combined mechanism, the output of which can be measured with electrical instruments. Unfortunately for the accurate determination of efficiency and location of losses the steam engine indicator is inherently subject to many more errors than are electric measuring instruments, so that accurate engine indication is an art requiring considerable study and skill. The work above mentioned is a complete and thorough treatise on the subject, compiled from the regular issues of "Power," giving complete descriptions of all the apparatus involved in indicator measurements with instructions as to its use and an analysis of the results obtainable, and particularly of the errors which enter into these results and the corrections which may be applied.

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# THE 1899 ELECTRICAL EXHIBITION.

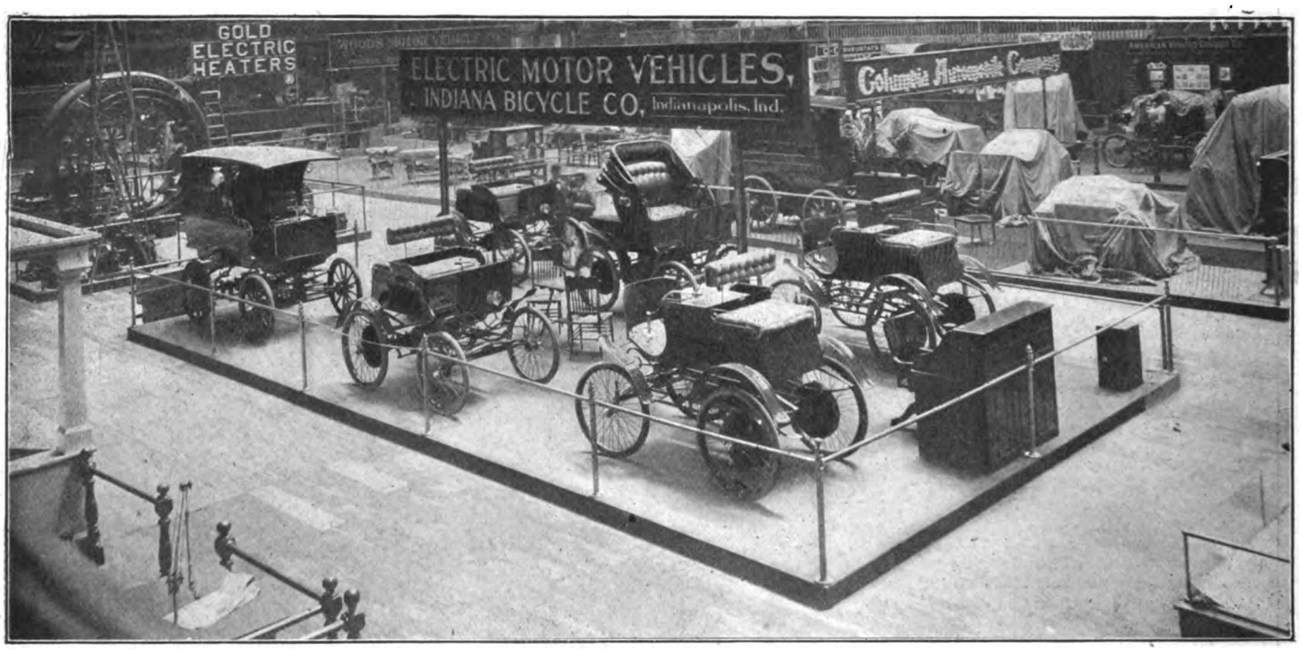
The third electrical show opened in Madison Square Garden, New York City, with its usual brilliancy, upon the evening of May 8th, with an attendance of several thousand people. Thanks to the efforts of its officers it contains the first general exhibition of automobiles. To those who can afford pleasure vehicles of this at present rather luxurious type, this feature of the exhibition evidently appeals strongly, if one may judge from the intelligent interest in the questions of cost, life, capabilities, etc., a large part of which is evidently not pure curiosity, but the outcome of a desire to determine, before purchasing, the relative merits of the different makes. The very fact that this is the first automobile exhibition in this country and that all the vehicles are electrical is an indication of the tendency toward the use of that power in preference to all others.

The illumination of the garden was this year put in the hands of Mr. Luther Stieringer and is unusually successful. The lighting is effected entirely by means of frosted incandescent lamps, some outlining the trusses of the roof, as usual, supplemented by 32 hanging clusters of 16 lights each, and other clusters in the galleries.

Outside of the exhibits of manufacturers and dealers, notes of which will be found on the following pages, the features of general interest are the government exhibit, the collection of historical arc lamps, wireless telegraphy, the transmission of sound by means of a radiophone, the cave of the winds, the Bell theatrophone, the theatre lighting exhibit, the Wehnelt interrupter and the Roentgen ray exhibit in the grotto.

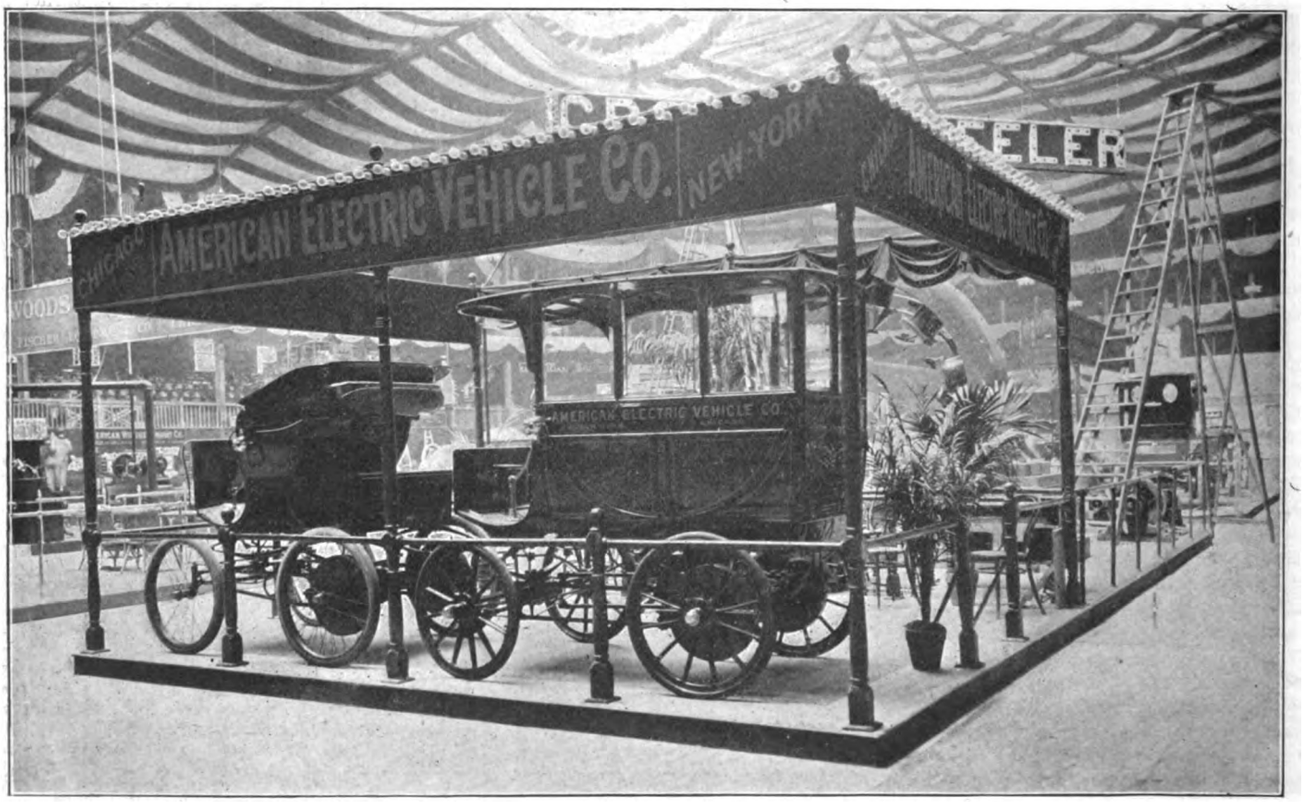



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THE WAVERLEY ELECTRIC AUTOMOBILES.

THE INDIANA BICYCLE COMPANY, Indianapolis, Ind., has a striking line of Waverley carriages, the first general exhibit of its output in New York City. The company manufactures these equipments complete with the sole exception of the woodwork, constructing in its own shops the batteries, motors, tires, etc. The vehicles are all supported on stiff running gears of cold drawn seamless steel tubing, each member of this gear or truck being two tubes in height, constituting a stiff truss. The forward bolster is a strong diamond shaped arrangement of tubes swiveled to the gear through a vertical fifth wheel, giving flexibility when running over uneven roads, without straining the gear or body. All wheels are on ball bearings and fitted with single tube pneumatic tires, those of the lighter carriages having wire spokes and those of the heavier vehicles wooden spokes. Each vehicle is driven by one 4-pole motor of the circular yoke type with internally projecting laminated fields. On the armature shaft is a compensating gear of the well-known bevel pinion type, the ends of the shafting driving enclosed single reduction gears on the hubs. The brake is a band on the compensating gear. Five speeds are provided in the forward and three in the reverse direction by means of the usual series multiple arrangement of the batteries, a starting rheostat on the first notch and a field loop on the last. The reversing lever consists of a button projecting from the end of the controller handle and interlocked so that it can only be reversed in the off position. An emergency switch, consisting simply of a Yale lock with a




THE AMERICAN ELECTRIC VEHICLE COMPANY'S CARRIAGES.

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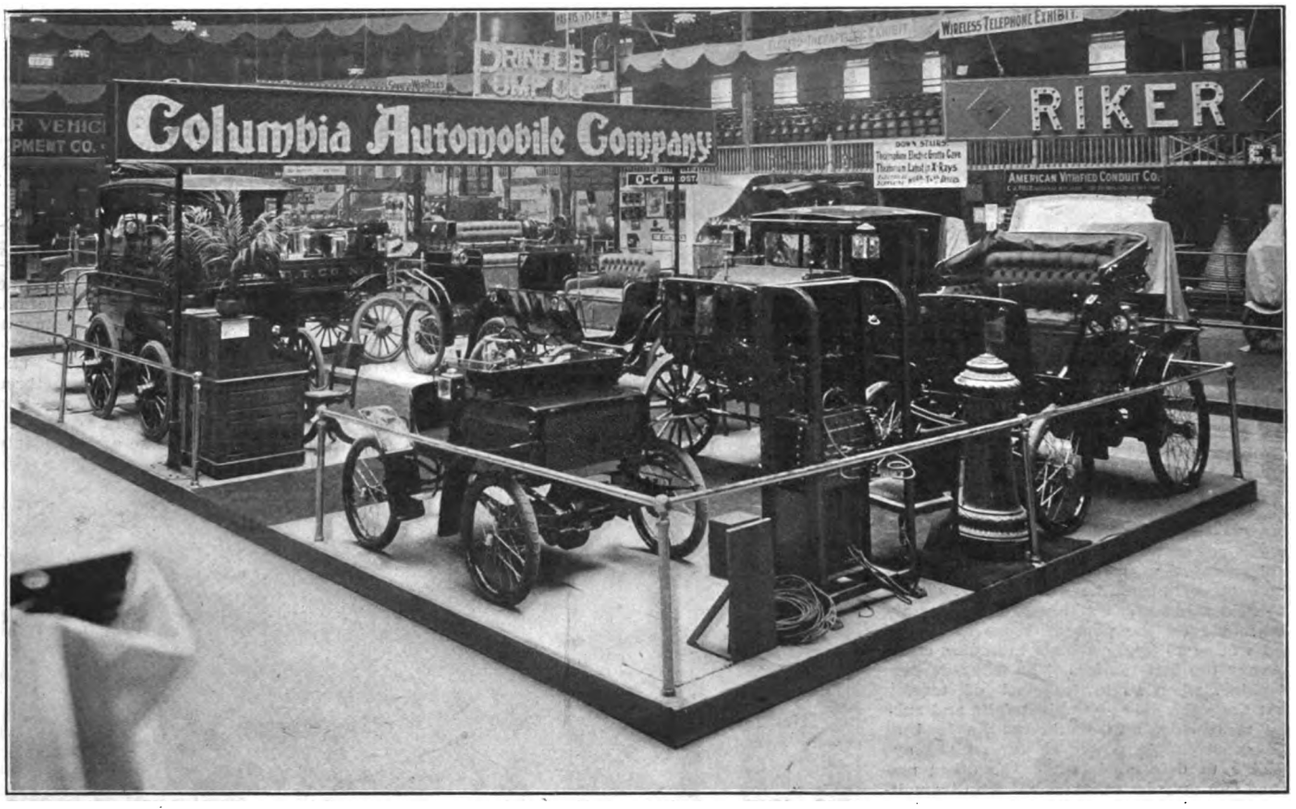
switch attached thereto, is provided. The lighter vehicles are suported on reverse elliptic or X springs forward and double elliptics at the rear, while the heavier ones, including the delivery wagon, have platform springs. These heavier vehicles also have worm gears in the steering mechanism, doing away with any yanking of the operator's hands when running over obstructions.

THE AMERICAN ELECTRIC VEHICLE COMPANY, Chicago, Ill., shows one delivery wagon and one Stanhope. The latest types of this company's vehicles embody novel running gears consisting of a single reach between the motor at the rear and the forward bolster. The reach is swiveled in such a way as to give flexibility to the system. The vehicles are driven by one 4-pole circular yoke type motor, with a differential gear on the armature shaft opposite the commutator, the ends of the shaft meshing with ordinary single reduction gears and wheel hubs. The company makes its own storage batteries with plates of the rolled lead pasted type, which attain the remarkable output of 5.9 amperes per lb. of cell complete at a 5 hour discharge rate. A test was recently made by G. W. Knox, Electrical Engineer of the Chicago City Railway, on a vehicle of this company's make, which ran 61.5 miles with two passengers under ordinary conditions of road, weather, etc.

THE COLUMBIA AUTOMOBILE COMPANY, successors to the Motor Carriage Department of the Pope Manufacturing Company, has six vehicles in its space, a brougham, a runabout, a dos-a-dos, a victoria, a delivery wagon and an emergency or fire department wagon. Of these the brougham is a new and strikingly handsome vehicle, its main features being as follows: The battery is divided and located in two compartments, one beneath the driver's seat and the other behind the body. There is no direct connection between the forward and rear running gear, the strain of driving being removed from the springs by braces extending to the body from each axle-tree. The vehicle is driven by a single motor with compensating gear in the motor shaft, with pinions on the end of the shaft engaging with annular gears fastened to the wooden spokes of the wheels, which are fitted with solid rubber tires. Band brakes are mounted on the hubs within these annular gears.

A NEW ELECTRIC BROUGHAM.—Besides exhibits of its well-tried lines of automobiles—one a Victoria which has traveled some 8000 miles—the Riker Electric Motor Company of Brooklyn shows a new brougham designed for the fine trade. The general appearance of this vehicle is more pleasing than that of lighter electric vehicles, as the battery necessitates a lesser departure from horse-drawn types than it does in lighter automobiles. Its construction follows the standard Riker principles. The running gear is made up of steel tubing swiveled to the forward and rear axletrees, constituting a sort of flexible truck, on which the body rests through double elliptic springs at the rear and a reverse elliptic at the front, giving practically a 3-legged support. Wooden wheels, roller bearings and solid rubber tires are used. The steering mechanism is of the pivoted hub type, the pivots being within the hubs. Two Riker motors are used and drive through single reduction spur gears fastened directly to the spokes of the rear wheels. The gear cases are enclosed and within the same enclosures are band brakes operating on pulleys integral with the main gear wheels. The accumulator, which is of the chloride type, is divided into two portions, one behind the body and the other below the driver's seat. The total weight of the vehicle is about 4200 lbs.

I. T. E. CIRCUIT BREAKERS.—The Cutter Company of Philadelphia shows, besides a number of its standard breakers, some of a brand new design. One of these new instruments is constructed for railway voltages and shown in two sizes, the larger with a capacity of 1500 amperes. It is of the single pole, double break type, with finely laminated leaf contacts in the primary break, the auxiliary contacts being placed at the top of the instrument so that any arc from them cannot injure the rest of the apparatus. Besides the regular carbon break, the upwardly extended arms are fitted with auxiliary copper contacts which are intended to make a low resistance shunt around the main contact of laminated leaves and absolutely prevent any arc from forming at the latter point in case the carbons do not make good contact. This auxiliary copper break is the second to open, the carbons making the final opening of the circuit. The instrument is closed by a toggle joint, giving a pressure of some 800 lbs. to the main contact. Besides this is a breaker with a similar main contact, but designed only for underload release, and intended for use on storage battery charging circuits. Several other combinations of various releasing arrangements are shown in the booth, among others a breaker fitted for overload and low voltage, another for underload and push button control, and still another fitted with three releasing devices, one for the usual overload, the other for low voltage and the third for over voltage. This is designed for the charging of storage batteries at constant potential, and is designed to let go when the storage battery voltage rises to the fully charged value, or falls due to a rapid discharge. The company also shows some pieces of apparatus of lines in which they have not until recently been manufacturers. One of these is motor controllers and starting boxes, and the other field rheostats.




THE EXHIBIT OF THE COLUMBIA AUTOMOBILE COMPANY.

CLINGING VS. SLIPPING BELTS.—The Cling-Surface Manufacturing Company, Buffalo, N. Y., makes a unique exhibit illustrating forcibly the comparative action of belts with and without a treatment of Cling-Surface. The apparatus shown in the booth consists of three dynamo electric machines of Westinghouse manufacture, one running as a motor and driving, by means of belts, the other two which are used as genera-

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tors. The latter machines are mounted on trucks allowing them freedom to roll in the direction of the belt tension, which is maintained and measured by means of spring balances. The belts are each 4 ins. in width and identical in all respects, except that one




THE TEST OF CLING-SURFACE.

of them has been treated with Cling-Surface and the other has not. The machine driven by the former supplies an electrically illuminated sign on the wall of the booth, reading "With Cling-Surface," and on the other machine is a similar sign, reading "Without Cling-Surface." The belt tension of both is maintained at the same value, viz., 115 lbs., by means of the balances, and it was intended to show the comparative slippage by the comparative drop in candle power of the lights on the two signs. The results obtained are, however, so much more satisfactory—considered from the standpoint of the company—than was expected, that the sign "With Cling-Surface" shines at full candle power with all the resistance in the field rheostat, while the other sign does not shine at all with all resistance cut out of the field rheostat. Further proof is readily obtainable on the part of those interested and willing to apply a little muscular effort to vary the belt tension. The Cling-Surface machine, when so far relieved of tension that the slack side of the belt falls and rubs the tight side, still maintains its load at the same candle power so far as the eye is able to determine, while the other machine can only be made to build up its voltage at all by a powerful effort applied to reinforce the initial tension of the spring balance.

AMERICAN ENGINE COMPANY, Bound Brook, N. J., exhibits a 50 kw. direct coupled generating set of which the engine is of the new "Duplex" compound design, which will be described later in these columns. The generator is of the company's own make and has no novelties in its construction except that the brush holders are of a new parallel motion type, the brushes being clamped in boxes which are radially pivoted to two arms, so arranged that the face of the brush remains parallel to the face of the commutator through a quite wide variation of the rise and fall.

THE BULLOCK ELECTRIC COMPANY, Cincinnati, Ohio, makes an extensive exhibit showing a number of its generators and motors, of which the largest machine is one of 65 h.p. capacity. One marine type generator is driven by a small Case engine and is fitted with two commutators, giving respectively 45 and 65 volts, the two being connected together and across one side of the Edison 220 volt three wire system, giving by various combinations of the circuits the following voltages: 45, 65, 110, 155 and 220. All of these pressures are carried to several motors controlled on the Bullock Company's multi-voltage system. Of these motors one is mounted in the headstock of a large lathe and another is direct geared to a shaper. They are shown in operation and controlled by Bullock controllers, which—the company takes considerable pride in announcing by means of placards—are of the magnetic blow out type. The exhibit also contains an overhead revolving globe lighted with appropriate illuminated signs.

THE WAGNER ELECTRIC MANUFACTURING COMPANY, St. Louis, Missouri, makes in its booth many transformations of electrical power, all on apparatus of its own manufacture. It takes 60 cycle alternating current which it steps up from 104 to 208 volts in its own transformers, passes it through instruments and switches on its own switchboard and feeds it to one of its 5 h. p. single-phase motors, which in turn is belted to a direct current generator. This again supplies power to motors direct coupled to ventilating fans.

THE BOSSERT ELECTRIC CONSTRUCTION COMPANY, Utica, N. Y., makes an attractive showing of its enameled stamped steel junction and outlet boxes and handsomely decorated panel boards. Many special designs are shown, among them stamped brass fittings for marine work, special boxes for flush switches, etc., besides complete equipments of distribution panels with switching arrangements which the Bossert Company makes in addition to its steel boxes.

THE AMERICAN CIRCULAR LOOM COMPANY, Boston, shows in its booth a great cone coiled up of its flexible conduit, the advantages of which, besides those of its enameled steel piping, known as electroduct, are well brought out by the company's representatives.

THE ADAMS-BAGNALL ELECTRIC COMPANY, Cleveland, Ohio, makes a general exhibit of its various types of arc lamps which now include lamps for all methods of working commercially used. Besides the standard inclosed arc for direct or alternating 110 volt circuits and lamps designed to work in multiple or two in. series on 220 volt circuits, it shows a line of series inclosed arcs for constant current circuits, the practical use of which is illustrated by two full-sized curved-neck street lamp posts at the corners of the exhibit, each carrying an arc lamp, the two being supplied by a small Brush machine in a neighboring exhibit.

THE INTERNATIONAL CORRESPONDENCE SCHOOLS, Scranton, Pa., have a number of their staff of instructors constantly on duty at their booth explaining the advantages of their system of instruction. To illustrate some of their arrangements there is shown a three-phase rotary converter feeding through open wiring, the circuits of which can be readily traced, three incandescent lights in the delta and three in the star grouping. To engineers acquainted only with direct current these arrangements of circuits are always a mystery, as it is difficult to understand how two currents can cult to understand how two currents can combine into one of the same strength, or how there can be the same difference of potential between any two of three wires.



THE BOOTH OF THE GENERAL INCANDESCENT ARC LIGHT COMPANY.

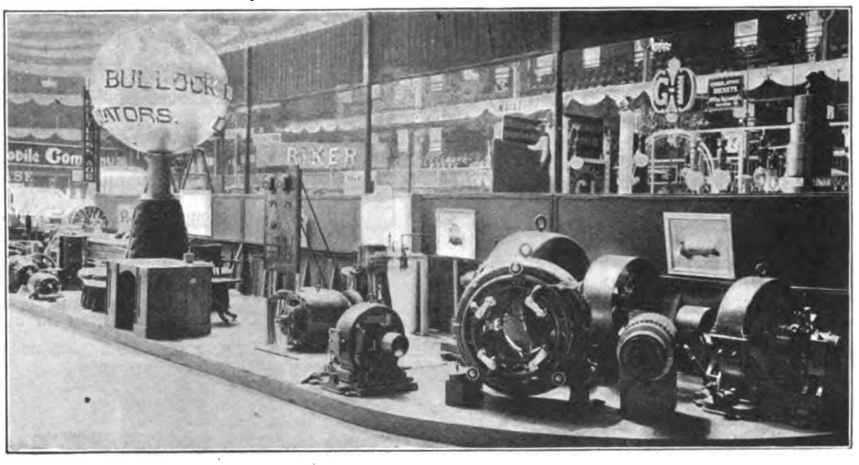
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THE STIRLING COMPANY, New York City, shows one of its full-sized water tube boilers complete with the exception of the brick walls, illustrating most clearly the arrangement of the tubes, headers, grate surface and the deflecting fire brick partitions by which the hot gases are compelled to pursue a devious course between the tubes and thoroughly part with their heat before leaving the boiler.

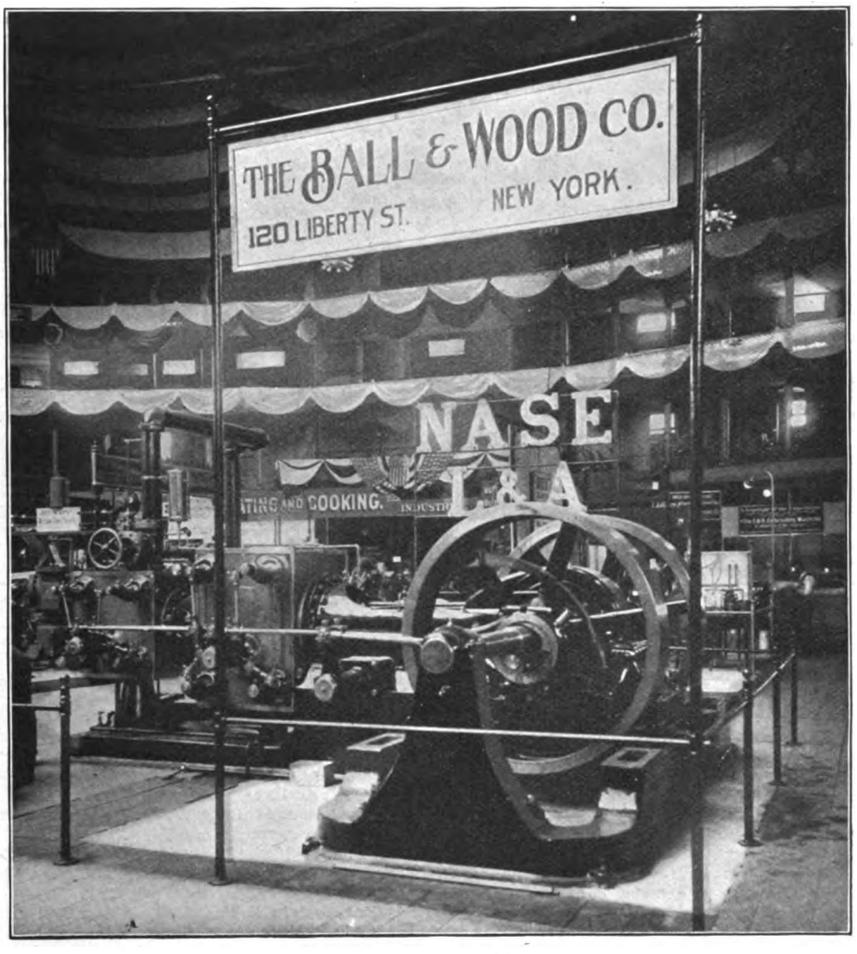
THE WOODS MOTOR VEHICLE COMPANY, successor to the Fischer Equipment Company, of Chicago, was so rushed with construction work that its vehicles were somewhat delayed in arriving at the exhibition. They are an unusually handsome group for automobiles and consist of a runabout, a trap, a brake, a Stanhope and a hansom. The mechanical equipment of the vehicles exhibits no striking departures from what is coming to be standard automobile practice, viz., hub steering, single reduction gearing, rigid suspension on the running gear, solid tires, wooden-spoked wheels, etc. All but the runabout use two motors with band brakes on the armature shafts, the pinions on which mesh direct with gears on the main hubs. The runabout is a single motor machine with axle drive and a differential or jack-in-the-box inside the gear meshing with the motor pinion. The storage batteries used are either the American or the Willard.

THE CROCKER-WHEELER COMPANY, Ampere, N. J., makes a striking exhibit, the central feature of which is a very large field frame and brush holder ring, the external diameter of which is about 12 ft. Grouped around this are various sizes and types of its bipolar and multipolar machines, controllers, mill motors, etc., one odd machine having a vertical shaft, its armature rotating in a horizontal plane.

THE ORIENT ELECTRIC COMPANY, Youngstown, Ohio, makes an extensive exhibit of its standard lamps, which are of the single loop anchored filament type. In the line of special lamps it shows its long neck lamps for illuminated signs, 4 c. p. lamps and a 3 coil spiral high candle power type. In the booth there is also a complete line of miniature lamps, white and colored, made by Herman Boehm, of Youngstown, especially for the Orient Company.




THE BULLOCK ELECTRIC COMPANY'S APPARATUS.




A BALL & WOOD ENGINE.

THE H. B. CAMP COMPANY, Aultman, Ohio, shows a full-sized conduit of 16 ducts, 20 ft. in length, complete with brick manholes at the ends. The latter serve as piers between which the conduit supports its own weight as a beam, illustrating the strength and rigidity of the combination of cement and vitrified duct. Distributed along the top of the conduit are special forms, elbows, branches, curves, etc.

THE GENERAL INCANDESCENT ARC LIGHT COMPANY, New York City, occupies one of the two large triangular spaces at the Madison Avenue end of the Garden. Here it shows extensive lines of apparatus of its own construction, enclosed arc lamps, switches and switchboards, magnetic switches, outlet boxes, etc., as well as the product of the Paragon Fan Company, which it controls, and of the Wright Discount Meter Company and Chicago Rheostat Company, for whom the G. I. Company is the eastern agent. Two lines of discount meters are shown, one the familiar Wright instrument and the other the Hoyt discount meter, a mechanical instrument with working parts consisting of a solenoid operating on a plunger suspended over a pulley to which is attached a ratchet and a pawl to retain it in the position of maximum deflection, and a dash pot to prevent sudden jumps.

THE H. W. JOHNS MANUFACTURING COMPANY, New York, shows the new Noark fuse, the invention of Mr. Joseph Sachs. This is an enclosed fuse, using an alloy and enclosing powder carefully chosen to give a chemical absorption of the metal upon vaporization to prevent arcing. A detail of this fuse, which will immediately appeal to all who have used enclosed fuses, is an indicating device of the simplest character which shows at any time whether the fuse is burnt out or not. It consists simply of a fine wire of high resistance alloy just outside the enclosing tube of the fuse and connected from one terminal to the other. As soon as the fuse burns out, the current is thrown on this fine wire, which immediately vaporizes, giving by its absence indication that the fuse has been overloaded and has broken the circuit. The action of the fuse is strikingly illustrated in the booth of the H. W. Johns Company by short circuiting 15 ampere open fuses and 25 ampere Noark fuses straight across the Edison mains with 235 volts. The former give the usual report and flash, while the new type gives no visible or audible indication of the sudden strain upon it and the way in which it does its duty.

THE JOHN A. ROEBLING'S SONS COMPANY, New York City, makes a complete display of samples of its various copper products. In the way of special articles of interest are several large copper ingots, a case containing sections of the last laid Commercial cable, including the three different sizes, the shore ends, intermediate and deep sea sections, and a splice of the large three-phase 0000 underground cable which the Roebling Company has made for the Metro-

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politan Street Railway Company for 6000 volt distribution. Besides these are paper insulated cables for telephone work and terminal heads for the same.

THE INCANDESCENT ELECTRIC LIGHT MANIPULATOR COMPANY, Boston, Mass., shows in practical operation its device for removing or cleaning, without the use of step ladders or staging, inaccessible incandescent lamps at considerable elevations. The value of the device is so easily appreciated upon seeing it working that the exhibit is proving a great source of sales for the company.

MACHADO & ROLLER, of New York, have one of the most complete exhibits in the building, consisting of Whitney electrical instruments of all sorts, ammeters, voltmeters, wattmeters, testing sets, etc.

THE BALL & WOOD COMPANY, New York City, shows one of its engines with rolling valves of the Corliss type. The engine shown is a tandem compound with a frame fitted for two dynamos, one direct-coupled to each end of the shaft. The latter machines are not in place. The exhibit attracts a great deal of attention on the part of engineers and engine users who appreciate the combination of the advantages of the Corliss valve and the shaft governor, which allows the economical features of low speed engines to be obtained in the high speed type.

THE COLUMBIA INCANDESCENT LAMP COMPANY, St. Louis, Mo., shows its products in the exhibit of Mr. R. B. Corey of New York. A show case at the front of the booth contains lamps in different stages of construction, showing the processes of manufacture. The filament is shown in a celluloid compound form in a vial, then as a raw filament and finally in its carbonized and treated state.

THE ELECTRICAL ENGINEER INSTITUTE OF CORRESPONDENCE INSTRUCTION, New York, occupies a booth where its instructors distribute literature and perform experiments, giving brief talks and lectures thereon to show the interest, scope and value of its courses of instruction.

THE JOSEPH DIXON CRUCIBLE COMPANY, Jersey City, N. J., has an exhibit of graphite products for electrical and other uses, including resistance rods, boxes for baking lamp filaments, graphite dust, electrotyping graphite, belt-dressing and lead pencils of almost innumerable variety.

THE STANLEY ELECTRIC MANUFACTURING COMPANY, Pittsfield, Mass., has none of its heavy apparatus on show, but makes an elaborate exhibit of its various details, switchboard instruments, etc. Among other things it shows its high potential switch of the pole type for pressures of 10,000 volts and over, as well as its well-known shutter switches, rotating fuse switches, etc. A new instrument is a combined high potential switch and fuse, consisting of a handle carrying two knives, which may be completely removed from the clips buried in the board. A fuse running through the body of the handle connects these two knives. The company's latest designs of lightning arresters with double cones and a new form of line discharger are also shown. The latter consists of a series of glass tubes containing carbon shot, the whole about 5 ft. in length, in series with a spark gap. In the line of measuring instruments the company shows its well-known static voltmeters and ground detectors, and a new line of hot wire instruments in which it takes considerable pride. These are fitted with Foucault damping discs and are dead beat. They are made up both as voltmeters and ammeters in two forms, one for switchboard and the other for portable use.

AMONG OTHERS REPRESENTED are the following:

American Electric Novelty & Mfg. Co., New York City.
American Mutoscope Co., New York City.
American Pulley Co., Philadelphia, Pa.
American Vitrified Conduit Co., New York City.
American Min. & Dec. Lamp Co., New York City.
Allgemeine Elektricitats Gesellschaft, Berlin, Germany.
Buffalo Forge Co., Buffalo, N. Y.
Bryan-Marsh Co., New York City.
Cincinnati Shaper Co., Cincinnati, Ohio.
Dale Co., The, New York City.
Emerson Electrical Mfg. Co., St. Louis, Mo.
Edison, Jr., Electric Light & Power Co., New York City.
Forbes, W. D., & Co., Hoboken, N. J.
Frink, I. P., New York City.
Fischer Foundry & Machine Co., Pittsburg, Pa.
Griffin, A. A., Iron Co., New York City & Jersey City, N. J.
Gold Car Heating Co., New York City.
Hill Electric Co., W. S., New Bedford, Mass.
India Rubber & Gutta Percha Ins. Co., New York City and Glenwood, N. Y.
Jones & Son, J., New York City.
Katzenstein & Co., L., New York City.
Libbey Glass Co., Toledo, Ohio.
McCay Engineering Co., Baltimore, Md.
Mfgrs. & Inventors Elec. Co., New York City.
National Gramophone Co., New York City.
National Meter Co., New York City.
Northern Eng. Co., New York City.
Niles Tool Works, New York City & Niles, Ohio.




THE GOVERNMENT EXHIBIT.

A CAMP CONDUIT.

ROEBLING WIRES AND CABLES.

STANLEY INSTRUMENTS.

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## OBITUARY.

CAPT. ALFRED EPHRAIM HUNT, President and General Manager of the Pittsburgh Reduction Company, died in Philadelphia, April 26, at the age of 44 years. His death is supposed to have been indirectly due to malaria contracted in the recent war, Capt. Hunt having commanded a battery of the Pennsylvania Light Artillery in the Puerto Rican campaign. Capt. Hunt's engineering education was obtained at the Massachusetts Institute of Technology, from which he graduated in 1876, his course having been that of metallurgy and mining engineering. His business career commenced with the U. S. Geological Survey, from which he went to the Bay State Iron Works in South Boston, afterward doing some pioneer work in the opening up of the copper district in Northern Michigan. In 1888 Capt. Hunt organized the Pittsburgh Reduction Company to carry on the production of aluminum under the patents of Chas. M. Hall. The progressive work of this company is well known to electrical engineers and was largely due to Capt. Hunt's own personal enthusiasm, which hastened the introduction of aluminum for many uses in which its advantages would not otherwise have been so promptly and clearly recognized. Notable among these is the use of aluminum in place of copper for electrical conductors, particularly long distance transmission lines, which was, during the last year or two of Capt. Hunt's life, a particular hobby and was at the time of his death just coming into extended use, owing to the high price of copper. Capt. Hunt filled besides his position with the Pittsburgh Reduction Company the offices of Vice-President of the Georgia Beauxite & Mining Company, Vice-President and Treasurer of the Hunt Air Brake Company, Vice-Chairman and Treasurer of the Pittsburgh Testing Laboratory. He was also a member of the American Society of Mechanical Engineers and of the Iron and Steel Institute of Great Britain. His life's work will leave a lasting impression on both the engineering and financial departments of the metallurgical industries.

## PERSONALS.

MR. J. P. ORD, Second Vice President and Comptroller of the General Electric Company, has sailed for Europe, and expects to be away for about two months.

MR. H. H. BROOKS, General Manager of the American Circular Loom Company, of Boston, has returned home after a visit of several months to Bermuda.

DR. EDWARD HOPKINSON, the well-known English electrical engineer connected with the manufacturing establishment of Mather & Platt, and a brother of the late Dr. John Hopkinson, sailed from New York May 13th, after a visit of about one month in this country inspecting the latest electrical installations.

GEORGE G. WARD, Vice President and General Manager of the Commercial Cable Company, sailed May 17th for Cologne, where he will consult with the officials of the German Atlantic Telegraph Company on the subject of the new cable between Germany and the United States via the Azore Islands. The Commercial Cable Company's steamer "Brittania" has already started for the Azores to make soundings to determine the most suitable route.

KEMPSTER B. MILLER, recently with the International Correspondence Schools of Scranton, Pa., has accepted a position as engineer with the Kellogg Switchboard & Supply Company of Chicago. Mr. Miller's return to engineering work and designing will be a notable gain to independent telephony in general and the Kellogg Company in particular, as those who remember his work with the Western Telephone Construction Company will realize. Although a young man, Mr. Miller has made good and varied use of his time since graduating from the electrical engineering course of Cornell University in 1893, part of his knowledge of modern telephone practice being gained in the patent office and the rest in the positions above named. Mr. Miller is well known to readers of the American Electrician through the many contributions from his pen, and notably the serial now running, entitled "American Telephone Practice."

## TRADE PUBLICATIONS.

THE ROYAL ELECTRIC COMPANY, Peoria, Ill., has issued a bulletin on its inductor generators, described in a recent article in the American Electrician.

HELIOS.—The well-known publication of the Heine Safety Boiler Company, St. Louis, Mo., giving valuable information in regard to the whole question of steam generation, has made its appearance as revised for the eighth edition, that of 1899. The work is more than ever elaborate and handsomely illustrated.

THE NEW YORK SAFETY STEAM POWER COMPANY has published the third edition of its catalogue on the Worthington water tube sectional steam boiler, describing and illustrating various installations where this boiler is used. Its well known peculiarities of side or end firing, iron casing, grate surface under entire boiler, etc., are with other advantages well emphasized in the new catalogue.

THE INTERNATIONAL CORRESPONDENCE SCHOOLS of Scranton, Pa., have issued a souvenir of their electrical exhibit, entitled "The New System of Education." The pamphlet gives a history of the schools, descriptions of the system of instruction and interior views of the headquarters of departments, interspersed with much valuable electrical information showing the thoroughness, accuracy and clearness of its lessons.

THE PITTSBURGH TRANSFORMER COMPANY has published a new catalogue of its type K transformer, giving more complete information as to the construction and performance of this instrument than is given in its first catalogue. The features of construction are given in such detail as to be of possible value to competitors, but the company has taken this course in order to thoroughly convince its customers that it is building a thoroughly well made and efficient transformer.

THE LUBRICATION OF GAS ENGINE CYLINDERS is a well recognized difficulty, owing to the extremely high temperatures attained by the burning fuel within them. The Jos. Dixon Crucible Company of Jersey City, N. J., makes up special graphite for such lubrication, which of course is not affected by heat nor burned, as is oil. Some letters describing the experience of users of this lubricant are given in a circular sent out by the Dixon Company, and speak well for the value of the material.

ENGINEERING AND POWER COMPANY, New York City, has published an illustrated catalogue of its steam specialties, chief of which is the Excelsior Indicator. This is a peculiarly compact and complete equipment with the Peerless aluminum reducing wheel attached ready for use, extra piston, two springs and cocks, boxwood scales, cord, cards, etc., etc., and is packed in one portable case. Besides these, the company handles planimeters, injectors, exhaust heads, damper regulators, lubricators, separators, etc. The General Manager of the company is Mr. A. C. Lippincott.

## BUSINESS NEWS.

THE MOUND TOOL AND SCRAPER COMPANY, St. Louis, Mo., is sending out a neat souvenir packing tool with all orders received during the month of May.

REMOVAL NOTICE.—The headquarters of the New York branch of the Ames Iron Works have been removed from 38 Cortlandt street to offices in the new Singer Building.

THE UNION BOILER TUBE CLEANER COMPANY, Pittsburgh, Pa., has begun an action in the United States Circuit Court to enjoin an alleged infringer from manufacturing, using or selling a certain device for cleaning the interior of boiler tubes.

MR. GERALD W. HART, formerly of the Hart & Hegeman Manufacturing Co., has severed his connection with that company, and is about to bring out a new line of goods. The first of this line is a two button push switch, and is put upon the market by the Hart Manufacturing Co., of Hartford, Conn.

A DYNAMO, ENGINE, BOILER, ETC., WANTED.—The Michigan Starch Company, Travers City, Michigan, announces that it has commenced the erection of a plant to consume 4,000 bushels of potatoes per day and is in the market for the power and lighting equipment therefor.

THE MOLONEY ELECTRIC COMPANY lately moved into more commodious quarters at the southwest corner of Second and Vine Streets, St. Louis, Mo., in order to obtain room for its growing business. The company reports an increasing number of orders and bright outlook for the future.

THE CHICAGO ADDRESS of the Buckeye Electric Company and the Jandus Electric Company, after May 1st, will be Room 1537 Monadnock Building. The increasing western demands for "Buckeye" incandescent and "Jandus" enclosed arc lamps necessitates the securing of larger shipping facilities.

THE CUTLER HAMMER MANUFACTURING COMPANY, Chicago, Ill., announces that during the month of April it has transacted the largest amount of business during the history of the concern. There has been a large demand for its crane controllers and also self starters for pumps and elevators.

THE WESTERN ELECTRIC COMPANY carries in stock a large supply of Samson spot cord. This cord is especially adapted for the suspension of arc lamps, for use as bell ropes in cars, and for trolley cord. Its smooth and pliable finish, combined with durability, lightness and strength, recommend it for many uses.

CONSOLIDATION OF MANUFACTURING INTERESTS IN BOSTON.—The Shawmut Fuse Wire Company, L. A. Chase & Company, the John P. Cushing Company and the Linton Manufacturing Company have combined their interests under the name of the Chase-Shawmut Company, with headquarters at 161-163 Fort Hill Square, Boston, Mass.

THE GARTON DANIELS COMPANY, Keokuk, Iowa, announces that since April 1st, the sales of Garton lightning arresters have been over double what they have been in the same period of any previous year. The company, in order to keep up its stock, has recently doubled its force of employees, and states that it will be able to meet any requirements for prompt shipments.

THE NATIONAL TELEPHONE COMPANY, formerly of Boston, Mass., has removed to St. Louis, Mo., where it has established a large factory at 1726 Glasgow avenue. The company is arranging to install a model plant at Belleville, Illinois, with a new multiple telephone system and gravity

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drop switchboard. The exchange will have trunk line connections with the Kinloch system in St. Louis.

THE EXPANSION OF THE STROMBERG-CARLSON TELEPHONE COMPANY.—The Independent Telephone Company, with a capital stock of $100,000, has been incorporated to take up the manufacture of the well-known Stromberg-Carlson telephone apparatus. The management will be continued in the same hands, but the business will be continued on a larger scale with increased facilities for manufacture.

THE AMERICAN STOKER COMPANY, New York City, wishes to invite the attention of the attendants at the electric light convention to its equipment of American stokers in the Bay Ridge generating station of the Kings County Electric Light and Power Company, Brooklyn. Owing to the interest of this installation a large number of those attending the convention will undoubtedly visit it and will see among other things a model stoker installation.

PARTRICK, CARTER & WILKINS, Philadelphia, Pa., have found that the advantages of their automatic set-back annunciators have been so generally appreciated that the type has been extended to the following sizes: 4, 6, 8, 10, 12, 16 and 20 numbers. The favor with which this design has been met is undoubtedly due to the extreme simplicity of the mechanism, and consequent reliability of operation. The company states that it is doing an enormous business with these annunciators.

THE WARD LEONARD ELECTRIC COMPANY announces a reduction in the price of its Carpenter enamel field rheostats and theatre dimmers. This reduction is as much as 30% in most instances. Although the Ward Leonard Company has maintained low prices in the line of field rheostats and theatre dimmers, it has made such radical improvements in cost, due to new designs and production in very large quantity, that it can make the present large reduction in price and still make a fair manufacturing profit.

CROCKER-WHEELER ELECTRIC COMPANY takes a justifiable pride in such a distantly remote feat as the successful competition of the Pencoyd Iron Works for the famous Atbara Bridge contract. The success of the American bid against all British competition was due to the short time in which the mammoth work could be turned out, which in turn is alleged to be due to the electric distribution of power through the Pencoyd Company's works. The Crocker-Wheeler Company has always advocated such power distribution, and in fact constructed most of the apparatus used by the Pencoyd Company.

THE C. & C. ELECTRIC COMPANY, 143 Liberty street, New York, has decided to open its own office in Chicago, Mr. Martin J. Insull, the former sales agent for the Chicago territory, having severed his connection with the company and located in New York as Vice-President of the General Incandescent Arc Lamp Company. Mr. E. Sanderson, who has been representing the C. & C. Company in St. Louis for a year past, was appointed manager for the Chicago territory on May 1st. A suitable office location has not yet been secured, but it is quite probable that quarters will be found in the Monadnock Block.

THE ELECTRIC ARC LIGHT COMPANY has removed its general offices to large and commodious quarters in the Bowling Green Building, 11 Broadway, New York. It has largely increased its manufacturing facilities, and can promptly ship direct and alternating current enclosed arc lamps. W. C. Hubbard, General Manager, reports that the company is very busy at present, and has just closed some good orders with such concerns as W. & J. Sloane, the Ogden Goelet estate, the Central Railroad of New Jersey, the Palais Royal, Washington, D. C., Campbell & Smith, Herren Bros., John Daubs & Sons, Pittsburgh, Pa., etc.

THE MONTAUK MULTIPHASE CABLE COMPANY has arranged for an exhibit of its automatic thermostatic fire detective cables at the Paris exposition next year. The company will make a very complete exhibit of its wires in connection with all interior electrical adaptations, and it will undoubtedly be one of the electrical features of that Fair. The convention of municipal electricians to be held in September of this year at Wilmington, Del., promises to eclipse any previous convention in numbers and exhibits. The progress of municipal fire protection from its beginning down to the present will be illustrated by apparatus in vogue during the various stages of invention. The Montauk Multiphase Cable Company will have a complete display of its product in connection with all interior wiring.

SALES OF COCHRANE FEED WATER HEATERS AND SEPARATORS.—The Harrison Safety Boiler Works of Philadelphia, Pa., announces a remarkably long list of recent sales of Cochrane heaters and purifiers as well as separators. Of the former, the largest orders were for 5000 h. p. for the Delaware & Hudson Canal Company, Scranton, Pa., and 3000 h. p. each for the Midvale Steel Company and the Granite City (Ill.) Steel Works. Of separators two of the 14 in. size were ordered by the Coplay Cement Company, one 12 in. and two 4 in. by The Gladstone, Philadelphia, and one 12 in. by the Roxborough, Chestnut Hill & Norristown Railway, besides a multitude of the smaller sizes. Separators of the Cochrane type were also ordered by the United States Government for the captured steamships, Isla de Luzon, Don Juan de Austria, and Isla de Cuba.

DAMPER REGULATORS.—No steam plant with good draft to the boiler should be without a damper regulator. They return their cost many times in a short period. With a good regulator, the steam pressure on the boiler can be kept uniform, and uniform pressure means steady power. It also means longer life to the boiler, because the pressure on every part is continuous. Irregular steam with the accompanying changes in expansion and contraction causes leaky tubes and leaks around bolt heads and seams of plates, necessitating repairs, loss of time, etc., generally much more each year than the cost of a regulator. A good damper regulator prevents alternate forcing and checking, and in that way saves from 5 per cent. to 10 per cent. in fuel. Care should be taken to select one without complicated parts, so liable to give way, to get out of order, and cause trouble and expense. James L. Robertson & Sons, New York City, have had twenty years' experience, and can speak intelligently on this subject. They will be pleased to answer all inquiries.

ELECTRIC POWER IN ROLLING MILLS.—The exacting speed requirements of the different machines constituting a rolling mill to move the ingots, plates, rails, etc., through the mill with a minimum of delay and a maximum of time usefully employed on each machine, and to prevent any one machine from causing a blockade by reasons of the fact that it is running too slowly, are best met by the distribution of power to the various machines of the mill by means of electric motors. Realizing this fact, the National Iron & Steel Company of Mingo Junction, Ohio, recently contracted with the Westinghouse Electric and Manufacturing Company for the installation of an electric motor plant. The equipment is now completed, the generating plant consisting of two 150 kw. direct coupled dynamos, supplying current of 250 volts. The mills and offices are lighted and nine traveling cranes are supplied, besides a number of 20 h. p. motors driving separate sections of the mill, which consists of a set of continuous traveling rollers extending over a distance of 600 ft.

A VERY HIGH HONOR has been paid the Pelton Water Wheel Company recently in the award by the Franklin Institute of Pennsylvania of the Elliot Cresson Gold Medal—made as a just recognition of what is regarded by them as one of the most valuable products of American genius that has ever been produced. This award is accompanied by an elaborate and exhaustive report made by a committee of scientists appointed for the purpose, which traces the history and progress of water-wheel practice from the early centuries down to the most modern and improved methods. The report concludes with the following para-


A COMMUTATOR NECESSITY.




The Only Article that will Prevent Sparking.
Will keep the commutator in good condition and Prevent Cutting.
Absolutely will not gum the brushes.
It will put that high gloss on the Commutator you have so long sought for.

50c. per Stick. $5.00 per Dozen.

For Sale by all Supply Houses.

Upon receipt of this coupon we will send FREE, sample stick.

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graph: "We have given this invention the fullest and most unbiased examination permissable within the time allowed us and within the compass of the literature at our command. We conclude that the Pelton Water Wheel possesses all the advantages of simplicity of construction, economy of installation and maintenance, adaptability to variable heads of water, transportability, a close and sensitive automatic regulation, and of high speed, which belong to other wheels of its class which have preceded it, but for efficiency and reliability it excells all others. We therefore deem the Pelton Water Wheel worthy of the Elliot Cresson Medal, and hereby recommend the award of same to the inventor."

MR. C. F. CROSELMIRE, whose platinum products are so extensively used in the electrical arts and industries, especially in the manufacturing of incandescent lamps, has recently received a $40,000 contract for electrical platinum attachments, to be used in preparing sea water for cleaning the streets of Havana, Cuba. The sea water is taken into capacious tanks and an electrical current is run through it by means of triangular pieces of metal, to which sheets of platinum, 1/1000 of an inch in thickness, are attached. The strong current of electricity run through the water breaks up the sodium chloride, giving free chlorine, which makes the water an excellent germicide, and with it the streets of Havana, and houses also, if necessary, will be flushed.

Mr. Croselmire spent very near all last year in the platinum mines of Russia and has made large business arrangements and purchases of crude platinum ore. During that time he has instituted processes in refining the metal whereby the percentage of platinum extracted from the ore is claimed to be greater than obtainable heretofore.

Mr. Croselmire will be pleased to quote prices and give information regarding platinum to any concern in the market for his goods.

THE WESTINGHOUSE MACHINE COMPANY'S EXTENSIONS.—Building operations are in active progress upon the extensions to the works of the Westinghouse Machine Company at East Pittsburg, Pa. The capacity of the foundry, machine and erecting shops will be doubled. The smithy and forge departments will be trebled in size. These extensions will make the main building 1200 feet in length, the width throughout being 230 feet. The warehouse and forge department will be nearly 700 feet in length. Large foreign as well as domestic orders for engines have necessitated these additions to the works. Messrs. Westinghouse, Church, Kerr & Company have recently contracted to supply several steam engines of very large horse-power. Among them are sixteen engines for the Third Avenue Railroad Company of New York City, to be of 4500 h. p. each, with a maximum capacity of 7000 h. p. each, also engines of equal capacity for the Bay Ridge power house of the Brooklyn Edison Company. These engines will be of the Corliss type, the first of this type built by the Westinghouse Machine Company. The demand for Westinghouse gas engines has greatly extended. These are being built in far larger sizes than hitherto. The Columbus Electric Company, Columbus, Ohio, has ordered a gas engine of 650 h. p. and another of 280 h. p. for direct connection to dynamos. The Consolidated Gas Company of Long Branch, N. J., has ordered a gas engine of 280 h. p. for electric work.

THE COPARTNERSHIP OF MR. CHAS. WIRT AND MR. IRVING B. SMITH, both of Philadelphia, under the firm name of Charles Wirt & Company, has been announced. They will continue the business, previously owned by Mr. Wirt, of manufacturing the Wirt dynamo brush and Wirt rheostat, articles too well known to require description here.

Mr. Charles Wirt entered the electrical business in the old Goerck Street Edison machine works, in New York City, in 1881. In 1882 Mr. Wirt was connected with the Western Edison Company of Chicago, and after leaving that connection returned to New York as chief electrician of the Bergman or New York Edison factory, at 17th Street and Avenue B. In 1889 Mr. Wirt was electrician of the standarzing bureau of the Edison Electric Light Company, with quarters at the Edison Laboratory, at Orange, N. J., where, in association with Mr. Kennelly and Mr. W. J. Jenks, specifications were formulated for the improvement of many parts of the incandescent system. In 1890 and up to the time of the failure of the Ansonia Electric Company of Chicago, Mr. Wirt was employed as electrician of that company and fathered the production of new designs and inventions, covering many lines of electric work, removing to Philadelphia soon after that time.

Mr. Irving B. Smith received his earlier education at Cornell University in the course of electrical engineering. Until forming the present partnership he has been connected with the firm of Green and Company, Inc., as chief of their electrical department. He has been in their employ since 1892, and as their electrical engineer has gained a considerable and well deserved reputation as a designer and constructor of scientific and commercial electrical instruments.

The new firm has been fortunate in securing additional room without change of address, by taking another floor in the manufacturing building, 1028 Filbert Street, an admirable location, within the business center of Philadelphia, close to the Reading Terminal Railroad Station, and well equipped for the line of manufacturing which they have chosen.

THE GROWTH AND DEVELOPMENT OF THE ELECTRICAL SUPPLY BUSINESS IN THE SOUTHWEST.—Ten years ago there were few electrical supply houses of any importance in the United States. Ten years has, however, caused a remarkable change in this branch of business speculation.

Only a few years ago the electrical, as well as numerous other forms of mercantile business, was transacted mostly in the East, in such cities as New York, Boston and Philadelphia. The demand, however, for this class of goods in the Middle and Western States increased so rapidly that the electrical supply houses were soon located in large numbers in central and Western cities. Chicago, St. Louis, Cincinnati, Detroit and other large cities were the sites of a rapid development in the electrical enterprise.

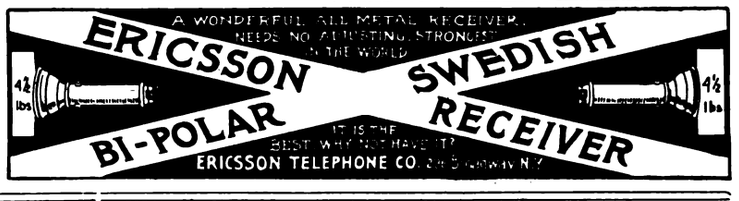
Six years ago the Western Electrical Supply Company of St. Louis, Mo., was organized for the purpose of transacting a general electrical supply business. This company was started at this time in a very small way, occupying at that time a floor area of only about one thousand square feet. Strict at-


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CROSS OIL FILTER



actually reduces oil bills 50 per cent. or more. Sent on approval. Capacities ranging from 3 to 150 gals. per day. Used in 23 countries. It is specially adapted to Electric Light and Power Plants.

THE BURT MFG. CO.
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Largest Manufacturers of Oil Filters in the World.






Will Outlast Several Ordinary Valves. TRY THEM.

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Pressure and Vacuum Gages Recording Gages
Pop Safety Valves Original Chime Whistles
Water Relief Valves Feed Water Regulators
Johnstone Blow Off Valves Lubricators—Oil Cups
Spring-Seat Globe and Angle Valves.
Engine and Boiler Supplies.

Crosby Steam Gage & Valve Co,

Office & Works: BOSTON, MASS.
Stores: 93-97 Oliver St., Boston. 78 John St., New York. 21-23 Lake St., Chicago. London, Eng.

THE STANDARD.



Perfect in Design. Faultless in Workmanship.

PLATINUM

In Sheet or Wire, any Degree of Hardness. FOR ALL PURPOSES.

BAKER & CO., NEWARK, N. J.
New York Office, 128 Liberty Street.


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tention to business, however, combined with energetic efforts to establish a business on a substantial basis and with a determination to carry a line of goods in accordance with the requirements of their customers, was followed by constantly adding to its line of agencies all high grade goods and maintaining the standard of all such goods as well as increasing the variety and the quantity from year to year.

The Western Electrical Supply Company at the present time has salesmen covering the Central, Western and Southwestern States thoroughly, and has become a well known factor throughout the entire country. It represents none but high grade manufacturers, and aims to supply the trade with goods that are excelled by none and equal to the best of anything in the market.

It has several lines of goods made especially for its own sale and directly under its general supervision, which practically establishes it as a manufacturer as well as a dealer. It is now located at 10 and 12 North Ninth Street, where it occupies an entire building, with a floor space at the present time of about 55,000 feet, and is very much crowded for room even in this spacious building.

The officers of this company are Mr. H. K. Gilman, President and Treasurer, and Mr. R. V. Scudder, General Manager, both of whom have long had experience in the electrical business.

The business of the company is divided into six large departments comprising the following: Electrical apparatus, lighting supplies, electric and combination fixtures, electric railway supplies, house goods supplies and telephone supplies.

Among some of the largest manufacturers whom it represents are the John A. Roebling's Sons Company, Trenton, N. J.; the Indiana Rubber and Insulated Wire Company, Jonesboro, Ind.; the Warren Electric and Manufacturing Company, Sandusky, Ohio; the Eddy Electric Manufacturing Company, Windsor, Conn.; the Ohio Brass Company, Mansfield, O.; the Western Telephone Construction Company, Chicago, Ill.; the Adams Bagnall Electric Company, Cleveland, O..

There are numerous other manufacturers of importance whom this house represents on fan motors, small power motors, switches and numerous other supplies of every description.

The Western Electrical Supply Company demonstrates quite fully its capacity for supplying and caring for the trade in its mammoth 750-page general catalogue. It also issues separate catalogues for its various departments. It is represented at the electrical convention in New York by President H. K. Gilman, who will be pleased to meet any of its friends and patrons, and, in fact, the entire electrical fraternity, such as is represented on this occasion.


**HAUNTS IN THE WILD WOODS**

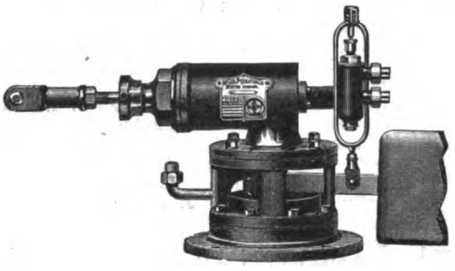
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**GAY PLACES FOR SUMMER OUTINGS.**

Either or both, can be found along the lines of the Chicago, Milwaukee & St. Paul R'y in Wisconsin, Minnesota, Northern Michigan, Iowa and the Dakotas. Among the many delightful summer resorts are Delavan, Waukesha, Oconomowoc, Elkhart Lake, Marquette, Madison, Kilbourn, Minocqua, Star Lake, Lakes Okoboji, Spirit Lake, Clear Lake, Big Stone, Frontenac, White Bear and Lake Minnetonka. In the north woods of Wisconsin, in the forests of Northern Michigan and Minnesota, and in the far stretches of the Dakotas true sportsmen can fish and hunt to their heart's content. For pamphlet of "Summer Tours," and "Fishing and Hunting," apply to nearest ticket agent, or address with two cent stamp, Geo. H. Hefford, Gen'l. Pass Agt., 555 Old Colony Building, Chicago, Ill.

*The* ***Mason Automatic Belt Shifter***

For automatically starting and stopping a power pump when driven by gas, gasoline or steam engines either direct connected, or belted, or where driven by belt from a line shaft, the pump being used on an elevator system or any service where the pressure or head of the pumping system is available to operate the shifter.



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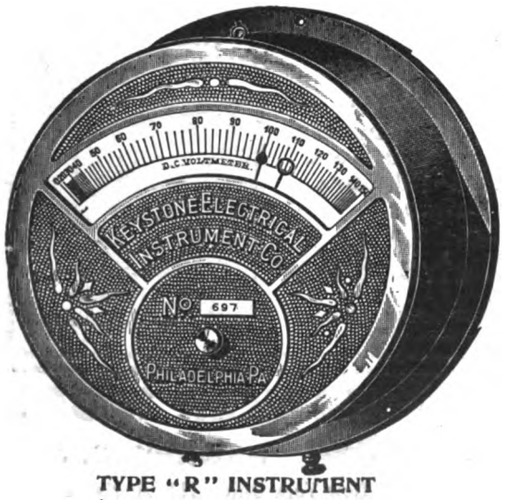
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# American Electrician.

Vol. XI. New York, July, 1899. No. 7.

## THE STREET RAILWAY SYSTEM OF KINGSTON, JAMAICA.

### AN EXAMPLE OF HIGH GRADE HYDRAULIC AND ELECTRIC ENGINEERING IN THE WEST INDIES.

BY HENRY E. RAYMOND.

It is not usual to find in cities of 50,000 inhabitants a street railway system built according to the latest improvements in every detail. This, however, is the case with the city of Kingston, Jamaica, which is perhaps one of the last places where one would look for such a perfect system. The streets, until very recently, were practically unpaved, and were drained by surface sewers, many of them being "crowned upside down," the drains being down the center of the street. The West India Electric Company, Ltd., an organization of Montreal capital, obtained the franchise to build and operate an extensive street railway, and also territorial rights to do the lighting. Starting work a few months after obtaining the franchise, they absorbed the old car company, which ran a service of very old mule cars, and have now completed works involving the expenditure of about $1,000,000.

The tracks are of 90-lb. steel girder rails, running through the city, and 60-lb. rails running through the country. The track is laid according to some very recent specifications, a somewhat similar construction being used in Buffalo, N. Y., U. S. A. The rails are laid on steel channel bar ties, 7 ins. wide, and are bedded in 8 ins. of concrete, which at the rail is raised so as to enclose it half way up the web. There are six miles of double track and 13 miles of single track.

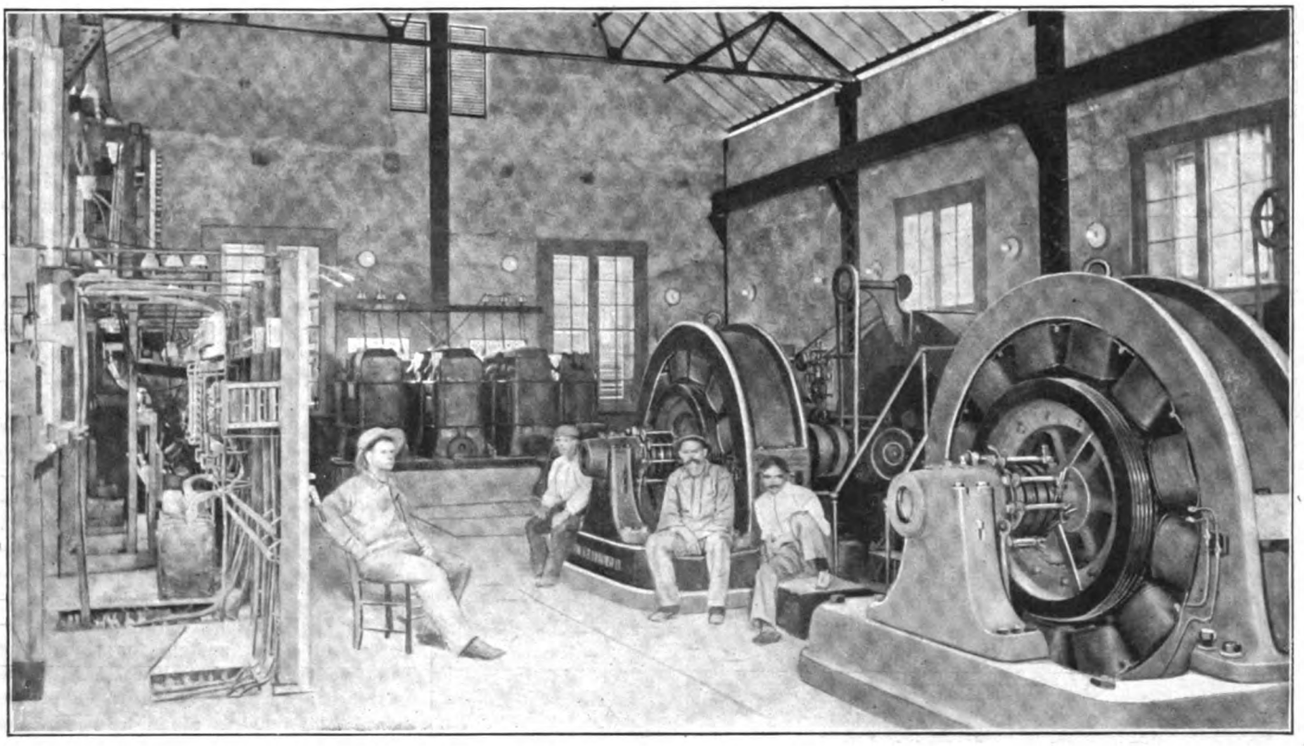


FIG. 1.—THE INTERIOR OF THE GENERATING STATION OF THE WEST INDIA ELECTRIC COMPANY, LTD.

Seventeen cars are run daily, the present equipment being 20 open cars, 6 trailers, or "market cars" (so called because they are run to accommodate the country people coming to the markets), and 2 sprinkling cars. The business done is large, and the system bids fair to pay well. Less than two weeks after starting it was evident that more cars were needed.

It was orignally the intention to work the line from a regular steam power plant, but it was soon evident that the cost of coal would be too great a percentage of the earnings, and prospecting was at once begun to find a suitable water power. The services of the Stilwell-Bierce and Smith-Vaile Company were enlisted, and this company sent its hydraulic engineer, Mr. R. H. Cooper, who went over the conditions and recommended the development of a power on the Rio Colre, 21 miles from Kingston. The same company then took the contract to design and install the power plant, complete, from its own designs, taking the river as it was and turning over a finished installation.

On the Island of Jamaica—as in all British Colonies—the "King's Highway" is of the first importance, and has to be protected under all circumstances. It happens here that the government road runs along the river bank at a height just sufficient to keep it above ordinary high water. A dam of sufficient height to give a practical head would have caused the flooding of several miles of road. It was found, however, that the location which was finally chosen was such that a dam 9 ft. high could be

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built, causing no inundation of the highway, except at extremely high water, and the water could be piped to a lower point down stream, where a head of 54 feet is obtained.

The dam is built of concrete and is 90 ft. wide, with cross section, as shown in Fig. 4. The flash boards are held in columns built up of Z bars, and extend 3 ft. above the dam. At the left of the dam is the skimming basin (see Fig. 7), from which the pipe intakes. The intake of the pipe is 10 ft. in diameter, narrowing to a diameter of 8 ft., which is its size throughout its length. It extends from the dam 6,240 ft. to the power house, and is built of ¼-in. steel riveted in 6 ft. sections.

It may not be out of place here to state that in cubic contents it is one of the largest (if not the largest) pipe lines in the world, and was constructed with untrained native labor, there being only two white men superintending the construction.

The power house is built entirely of steel and concrete, and is carried on foundations from 10 ft. to 16 ft. deep. The building stands directly in the bed of the river, and must needs be sufficiently strong, not only to satisfactorily hold the machinery, but also to resist the freshets, which come down, like all tropical floods, with tremendous force. The building is 70 ft. long and 36 ft. wide, and is built with latticed columns, and I beam girders throughout. The turbines, two of which are at present installed, are on the east side of the building, with room to the south for a third unit. The wheels are regular Stilwell-Bierce and Smith-Vaile Company's twin turbines, and are designed to develop 400 h. p. at 40 r. p. m. The generators, in common with all of the electrical equipment, are of General Electric manufacture. They are of the most recent construction and are designated as A. T. 12-300-400, that is, they are 3-phase stationary field, 12-pole, 300 kw. 550-volt machines, designed to be used with step-up transformers, which are of the air-blast type. Each generator feeds three transformers, which are connected with both secondary and primary in delta.

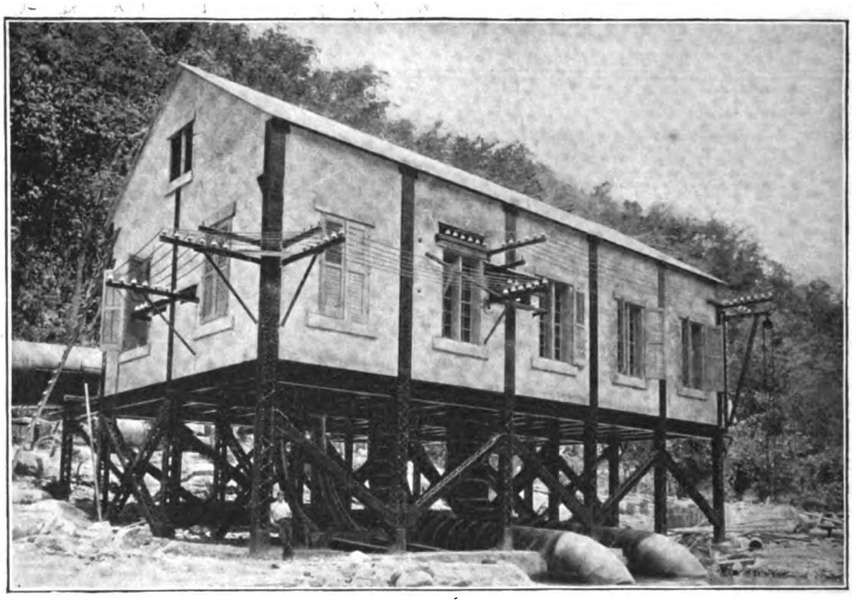


FIG. 2.—THE POWER HOUSE, SHOWING DRAFT TUBES AND UNDER FRAMING.

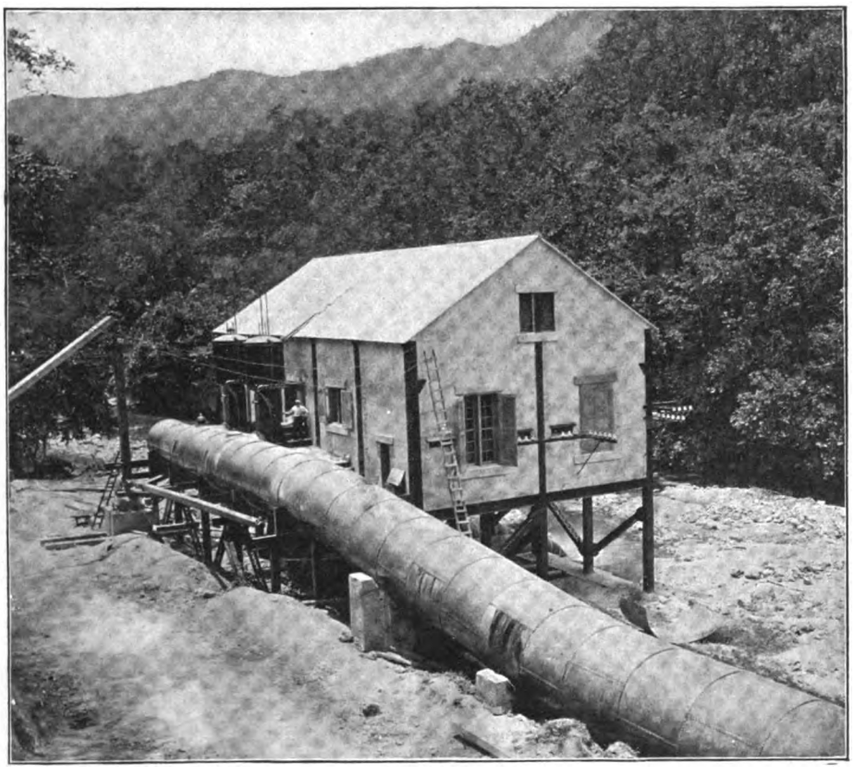


FIG. 3.—THE POWER HOUSE, SHOWING PIPE LINE, RECEIVER AND GATES.

The foundations for these transformers consist of concrete walls 12 ins. thick and 30 ins. high, with a row of concrete piers down the middle. The air chamber is made by flooring the top of this foundation with 2-inx12-in. pitch pine plank. The low-tension connections are made in the air chamber, and are led through porcelain tubes into conduits in which they are carried to the switchboard. The high-tension connections are made overhead, and are led out of the building through 12-in.x36-in. openings in the wall, to cross arms, on which they are carried around the building to another set of openings, through which they are brought to the switchboard. The blowers are set on the floor directly at the west end of the air chamber, the motors being raised on concrete piers 12 ins. high.

The switchboard consists of eight blue Vermont marble panels, two blank ones being left for the third unit. The high-tension panels for each set of transformers contain only the high-tension switches, which are of triple-pole, double-throw, oil-break form, the handle alone being on the front of the board. An auxiliary panel carries a triple-pole, single-throw, oil-break switch for paralleling the two transmission lines. All these switches are placed on the back of the board, the handles alone being on the front. The auxiliary panel is provided, also, with two astatic ground detectors, and six ammeters, connected to show the current in each phase. These ammeters are directly across the secondaries of current transformers, thus avoiding all high tension in the front of the board. The generator panels are each equipped with 3 single-pole, quick-break switches, and the necessary meters, field switches and synchronizing lamps. The exciter panels are equipped with the necessary switches and meters for two exciters, which operate at 110 volts. These exciters are 4-pole, moderate speed machines of 25 kw. capacity, each coupled

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directly to a single turbine 9 ins. in diameter.

The lightning arresters in this plant are placed on a frame made of 4-in.x6-in. pitch pine, and mounted on struts so as to bring them about 30 ins. from the face of the wall; 1-in. bolts, extending entirely through the frame work, struts and wall, hold them in place. This construction leaves 18 ins. clear behind the panels, in which space the wires to the transmission line are carried.

The low-tension wires are all carried in conduits beneath the floor, and rise only at the machines, switchboard and transformers. The high-tension wires are all carried on porcelain line insulators on wooden cross arms. From the transformer primaries they are run outside, through the holes before mentioned, and are carried on long pitch pine cross arms, around to the middle of the west wall, through which they are carried directly to the high-tension switches. There are two sets of bus wires, to which the two transmission lines are connected.

The power house is equipped with a jib crane of 5 tons capacity, which is outside the door, and a traveling crane of equal capacity. In order to avoid interfering with this crane, the high-tension wires are all run outside the building as described.

The transmission line is carried on 2 cross arms, on tubular steel poles, 4 wires being on the upper and 2 on the outer ends of the lower arm. Two telephone wires are carried on the lower cross arms next to the pole. There are 6 transpositions on the line, making 2 complete turns in the entire length. The transpositions are so made that the sets of 3 wires each spiral in opposite directions. The transmission line enters the sub-station in Kingston through a large, square opening in the rear gable.

The sub-station is built of brick, with a truss roof, and galvanized iron roofing. There is also a section of monitor roof for ventilation. There are at present 2 rotary converters, 6-pole machines, of 200 kw. capacity each. The converters are designed to run at 550 volts on the d. c.

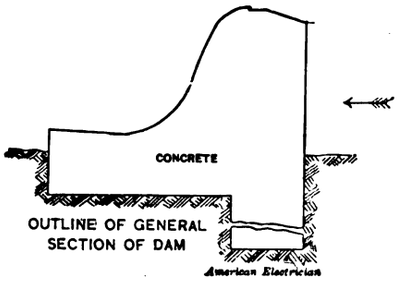



FIG. 4.—A CROSS SECTION OF THE DAM.

end. The system being 40-cycle, and the rotaries 6-pole, they run 800 r. p. m. In spite of the high peripheral speed they run very smoothly, and very coolly. They are self-excited, compound-wound, the compounding being done exactly as with a similar direct-current generator, with the German silver shunt across the series field.

When starting as a. c. motors there is, of course, a transformer action tending to induce a considerable potential difference across the field terminals. In order to avoid extremely high voltage across the shunt winding, the field coils are split up into 3 pairs of two in series, and are not connected until the machine is running synchronously. To avoid a short-circuited secondary effect through the series coils and the German silver shunt, a switch is placed in series with the shunt.

The step-down transformers are placed on a wooden air chamber, which, in turn, is placed over a duct or pit, through which the high-tension wires run. The sides of the air chamber are of 6-in.x 16-in. pitch pine, the bottom and top of 2-in.x12-in. pitch pine. The center line of weight is carried on short, wooden columns, supported by 3-in. steel rails placed across the top of the pit. The pit is 7 ft. wide and 4 ft. deep.

The low-tension cables run directly through a conduit to the switchboard.

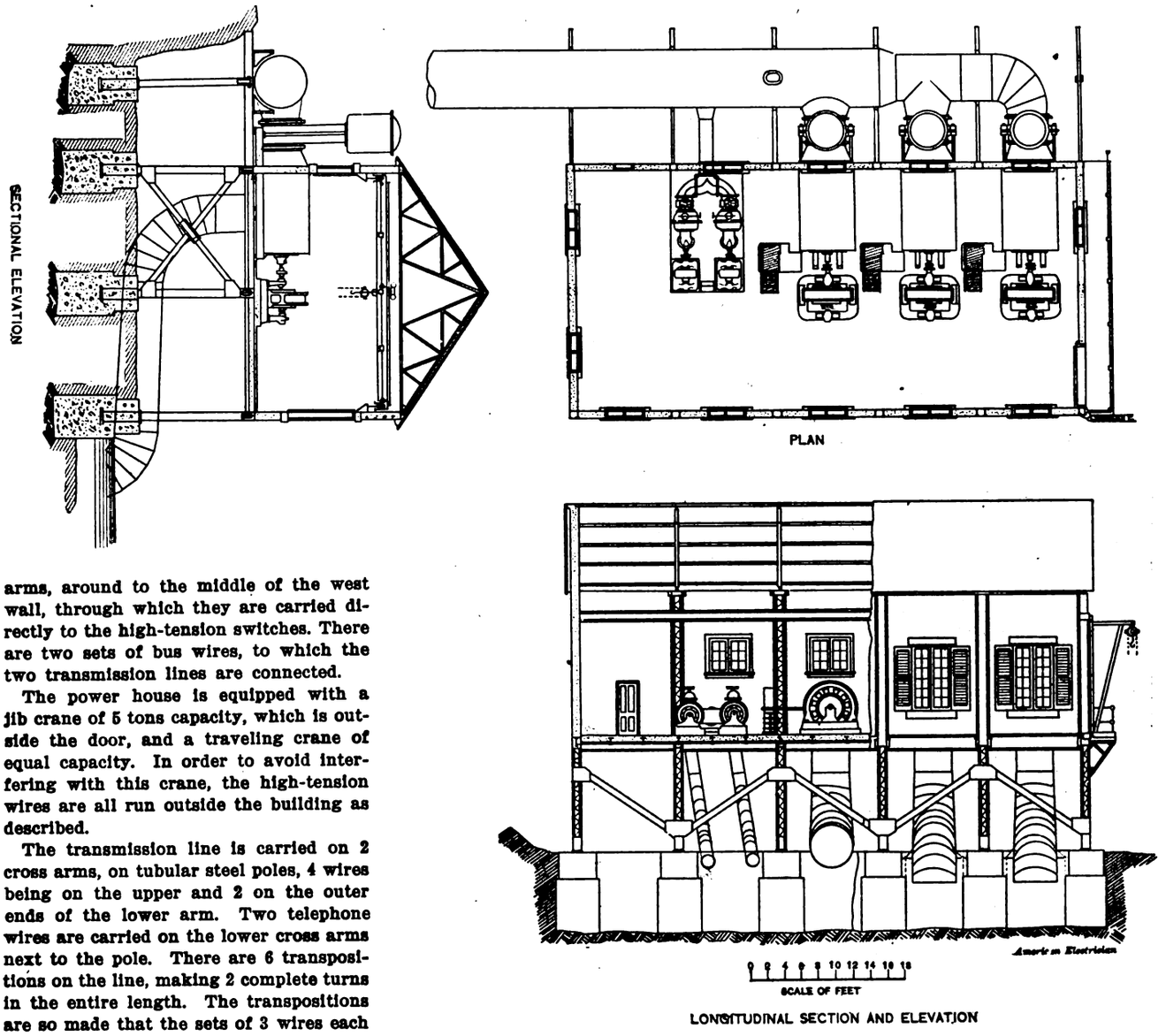



FIG. 5.—PLAN AND ELEVATIONS OF POWER HOUSE.

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The primary leads are carried to a set of bus wires, carried on short cross arms on posts set between the 2 rows of transformers. These bus wires lead through the current transformers for the high-tension ammeters, to the oil-break switches. The wires leading to the transmission line are connected directly to the high-tension bus wires on the boards and pass directly down into the pit. Through the pit they are supported on line insulators on cross arms set in concrete at each end. At the opposite end of the pit they rise, and pass up the wall behind the lightning arresters to 2 sets of cross arms, on which they are carried to the openings, through which the line enters.

The blowers and their motors stand on a wooden platform beyond the end of the air chamber, and are carried on the steel rails which cross the high-tension wire pit. The lightning arresters are on a pitch pine frame, similar to the one in the power house, but supported on corbels set into the brick wall. They are of the standard, short-gap type, and are connected 24 gaps to ground.

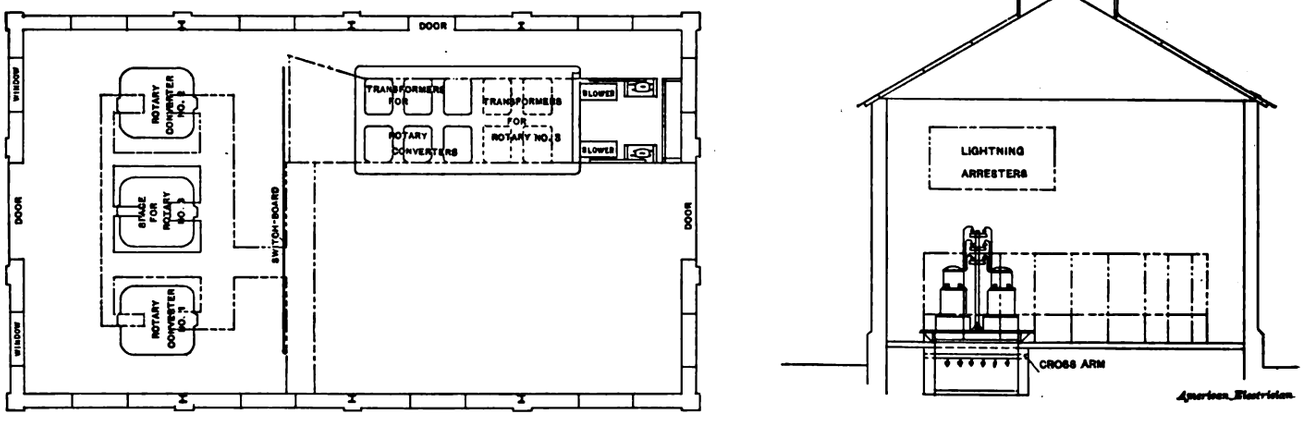



FIG. 6.—PLAN AND ELEVATION OF SUB-STATION.

The switchboard is of blue Vermont marble and consists of 9 panels, there being three for high-tension connections similar to those in the power house, one blank panel, two low-tension panels for the a. c. end of the rotaries, two standard railway panels for the direct-current side and one feeder-panel for four feeders.

The step-up transformers step up to 14,000 volts, at which pressure the power is transmitted to Kingston, where it is stepped down to 345 volts for the rotaries. The relative field excitations are adjusted so that at about ¾ load the rotaries will operate non-inductively. The rotaries may be started from rest, from either the a. c. or the d. c. side. The usual custom is, however, to start the generator and rotary from no cycles, and with a full field on the generator. It was found that with weak fields on the generator and rapid acceleration of speed the rotary will pulsate in and out of step, frequently reversing the polarity of the d. c. voltage. This is avoided by bringing the generator up to speed slowly, and keeping a strong field on the same. The normal non-inductive, full load alternating current for the rotary is 340 amperes, but only 200 amperes are necessary to start it from rest, and bring it up to speed as an induction motor.

The switchboards are provided with switches and a starting rheostat, so that either rotary may be brought up to speed

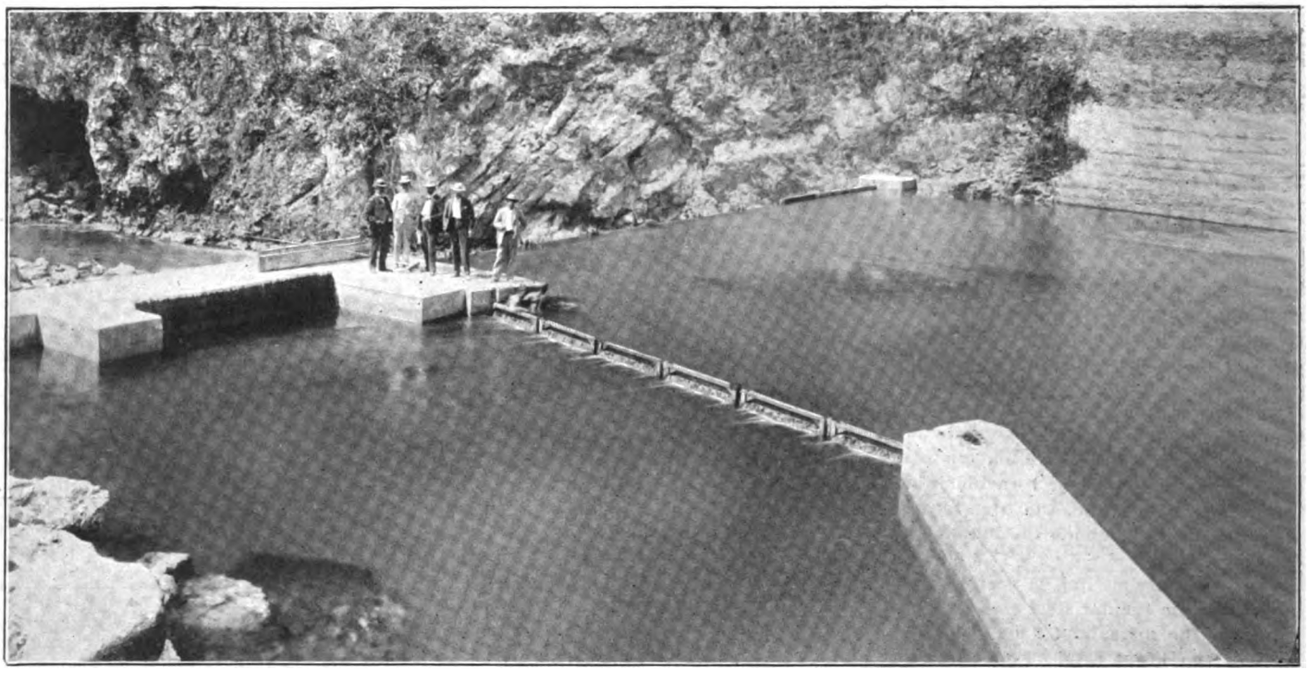
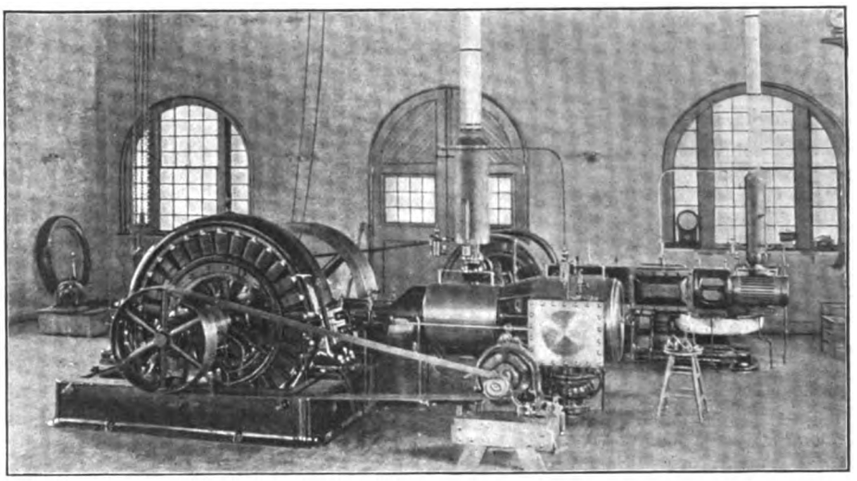


FIG. 7.—A VIEW OF THE DAM AND SKIMMING BASIN.

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as a direct-current motor, and, after synchronizing, be thrown in parallel on the a. c. end with the other rotary.

The general design of the plant is such that either generator unit can be operated on either transmission line, and either rotary unit the same. For its size it is one of the best equipped and best finished plants in existence; in fact, the entire system, including the dam, power plants, car sheds, track, and overhead work, is of the most substantial construction. The power plant started operation on the 1st of April, and developed a capacity, both in water power and electrical equipment which exceeded to a considerable extent, not only the guarantee, but even what was expected of it.

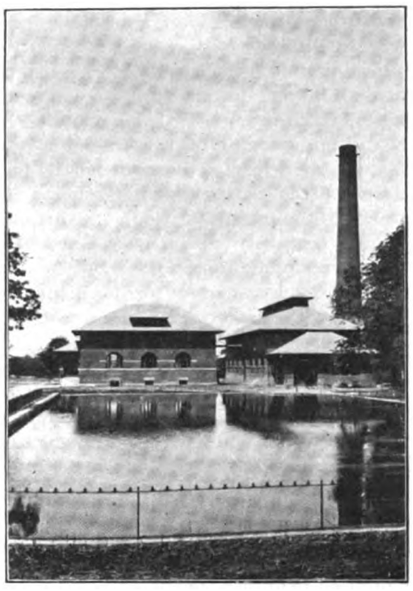


THE DIRECT COUPLED ALTERNATOR.

## THE POWER STATION OF THE OHIO STATE UNIVERSITY.

One of the most modern and complete systems to be found in the country for supplying heat and power from a central station to a group of large and widely separated buildings is that installed at the above institution in Columbus, Ohio. There are ten buildings in the group, having a total heating surface of 41,000 square feet. On the lighting circuit are 2200 incandescent and 11 arc lights, and on the power circuit 17 two-phase Westinghouse motors, from 1 to 30 horse-power. These motors are used for driving the ventilating fans in connection with the heating system, as well as power blowers, shop tools, electrical laboratory apparatus and the hay cutters, threshing and other machines in the dairy and farming department.

A 10-in. steam pipe, with suitable pressure regulator and with the proper reduction to suit the distance and size of the different buildings, leads out from the power station and is supported along the side of a brick tunnel nearly six feet square, and having a total length of 4100 feet, the longest distance to any single building being 2500 feet. Beneath the steam pipe is a general return pipe, in which the water of condensation gravitates to the hot well in the boiler house, as the grade is about 1 in 900. The wires for the light and power currents are also supported along one side of the tunnel, those for the high tension current being lead encased. The heating system embraces the Paul, Sturtevant, Buffalo and direct methods.

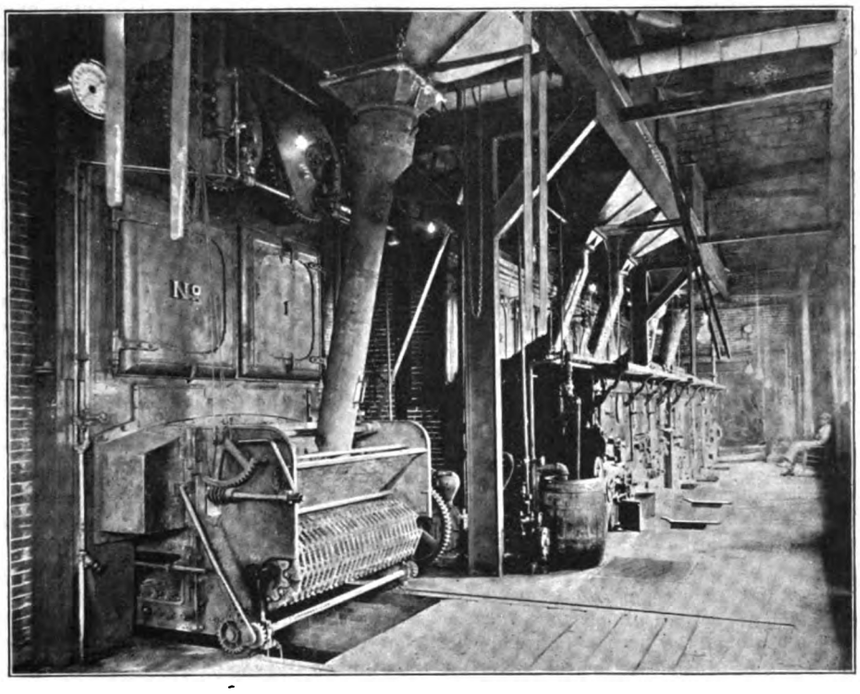


The steam generating equipment consits of five boilers, all of the Babcock and Wilcox make. Four of them are equipped with the Murphy smokeless furnaces, manufactured by the Murphy Iron Works, Detroit, Mich., while the one shown in the foreground of the view has the Babcock chain grate.

The coal is carried by conveyors to hoppers located above and in front of the boilers, from which it is delivered by chutes to the furnaces. The ashes are removed by an endless screw conveyor, and then elevated to bins from which the contents will readily gravitate through chutes into wagons placed outside the boiler house. The coal handling machinery is driven by a small vertical engine located in the boiler room, which, with all the coal equipment, was installed by the Jeffrey Manufacturing Company of Columbus.

The water for condensing purposes is taken from the end of the reservoir farthest from the station, and discharged into the other end through a five-inch pipe. This reservoir is designed for fire purposes, as well as for condensing, and is 90 ft. x 200 ft. and five feet in depth, and when filled contains 500,000 gallons. It is interesting to note that during the coldest weather of the past winter no part of this reservoir was frozen over. The water is pumped by a pneumatic system from a well beside a river 1700 feet from the reservoir, and 40 feet below its level.

The power equipment consists of two tandem compound engines. One is of the



THE BOILER ROOM, SHOWING MECHANICAL STOKERS.

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McEwen manufacture, and drives by a belt a 60 kw. 2-phase Westinghouse generator. The other is a Watertown engine, which runs at 240 r. p. m. and is direct coupled to a 125 kw. generator of the same make and character. The auxiliary equipment consists of Sweets direct separators connected above the throttles, a 200 h. p. Wheeler surface condenser and a Hine eliminator, connected with a Bundy trap, which are located in the basement. The station is in charge of Mr. W. C. McCracken, Chief Engineer.

The results that were obtained in tests carefully carried out by Prof. E. A. Hitchcock upon both the stokers and the Watertown direct coupled engine may be summarized as follows: The fuel used was Hocking & Thacker pea coal, the latter having a considerably greater calorific value as shown by a Mahler calorimeter and giving the higher figures mentioned below. The water apparently evaporated per pound of coal varied from 5.76 lbs. to 8.3 lbs., while the equivalent vaporization from and at 212 degrees per pound of dry combustible varied from 9.52 to 11 lbs.

The engine was given three runs under three different loads with a steam pressure of about 100 lbs. and a vacuum of about 21 in., the results being briefly as follows:

| | | | |
|---|---|---|---|
| Indicated h.p..... ..... | 142 | 125 | 92 |
| Electrical h.p..... | 126 | 107 | 73 |
| Efficiency of unit ..... | 88.4 | 85.5 | 79.3 |
| Lbs. of steam per i.h.p. hour, including that used by condenser..... ..... | 26.8 | 26.1 | 29.7 |
| Lbs. of steam per electrical h p. output including condenser ..... ..... | 30.2 | 30.5 | 37.4 |

## THE MANUFACTURE OF GRAPHITE.

In a paper presented by Mr. E. G. Acheson before the Franklin Institute an account was given of the process of manufacturing graphite to be applied commercially at Niagara Falls. From this paper the following paragraphs have been extracted:

Very early in my experiments on the manufacture of carborundum, I noticed that graphite occasionally formed in the portion of the furnace charge lying next to the cylinder or granular amorphous carbon, which passed through the center of the furnace, and which became heated to an extremely high temperature by the passage of a heavy electric current, and around which the charge was placed to receive the heat necessary for the formation of carborundum. Also that when ordinary bituminous coal coke was used to form the core, quite a large amount of it was converted into graphite, whereas, when petroleum coke was used, very little of it was made graphitic.

By a careful study of these formations it was found that the graphite formed outside of and surrounding the core was produced by the decomposition of the carborundum, which is, chemically, a carbide of silicon, and, by induction from a number of known facts, that that formed within the core was also produced from a similar decomposition of carbides, which were created by the chemical union of the carbon of the core with its contained impurities.

As the result of my investigations and deductions, I think the only commercial way to make graphite is by breaking up a carbide by the action of heat. The carbon should be freed from chemical combination by what might be termed the evaporation of its associated elementary substances. I have secured patents covering this method, and these have been made the basis for the organization of an incorporated company, bearing the name "Acheson Graphite Company." The company has now under way the erection of works at Niagara Falls, where the necessary electric current will be obtained from the Niagara Falls Power Company.

Several distinct forms of the product will be produced. One consists of forms or articles, made out of amorphous carbon, with the desired amount of impurity added thereto, which will afterwards be heated in an electric furnace and converted, more or less, into graphite. I have been carrying on this line of manufacture for a year or more, using the furnaces of the Carborundum Company to produce the graphitization, the articles having first been made by the arc-light carbon manufacturers. Over 200,000 carbon electrodes, measuring 15 inches in length, with about 1 inch cross-sectional area, were made for use in the Castner alkali process, nearly one-half of them having been shipped to Europe, to be used for this work in England and Germany. The life or efficiency of these graphitized electrodes is many times that of the same electrodes ungraphitized. I have also graphitized some tons of carbon plates, to be used in making dynamo and motor brushes, and a large variety of odd forms and sizes for divers purposes.

Another product—the one which will probably be of greatest importance—is an intimate mixture of pure amorphous carbon and graphite in fine powder. This will be put on the market for paint and foundry facing, and, as it has been formed at an exceedingly high temperature, it is quite pure, and possesses all of the qualities desirable for the purposes for which it is intended.

It is not the present intention of the company to enter into the manufacture of their product into finished form for the general market, but rather to encourage those who are now engaged in making up the natural graphite into articles of commerce to become buyers of their material, substituting it for that now used.

The company's plans, now being carried out, provide for the erection of a brick and iron building, 100x50 ft., on a plot of ground in Block No. 8 of the Niagara Falls Power Company's lands (adjoining the works of the Carborundum Company). Therein they will erect machinery for reducing coke to grains of the desired size, an electric furnace through which the prepared grains will pass in a continuous stream, a pulverizer for reducing the grains as received from the furnace, and a scalping sieve through which the product from the pulverizer will pass, that particles exceeding the 1/200 of an inch diameter may be removed. The final flour or powder will contain an amount of pure graphite proportionate to the percentage of impurities in the original coke. It is quite possible that, instead of using high-grade marketable coke, the fine refuse from the coke ovens, which is at present a waste material, will be utilized in the manufacture of this product.

## A NIGHT SCHOOL FOR A TELEPHONE COMPANY'S EMPLOYEES.

A recent innovation in the telephone field has been introduced by the New York and New Jersey Telephone Company to educate the employees in regard to installation and care of all sorts of telephone apparatus used by the American Bell Telephone Company. Mr. W. H. Brown, an electrical engineer, who graduated from Lehigh University in 1896, has been employed as an instructor in all branches of the telephone business.

The course of instruction, as outlined for the present, starts in with the rudiments of electrical science, and gradually leads up to the circuits involved in multiple switchboards, selective signal apparatus and power plants used in connection with telephone apparatus.

The company has divided its territory into sections, the main office of each section being the assembling point for the men to meet Mr. Brown, and to receive instructions through black-board exercises and illustrations concerning the work in all its details. So far these meeting points have been Jersey City, Newark, Paterson, Long Branch, New Brunswick, Elizabeth, Orange, West Brighton and Morristown.

The interest shown by the men has already proven that the matter of instruction in this form appeals to them in a stronger way than the correspondence system, which has been tried by the men for some time past.

The detail of a special man for this work was the outcome of classes which have been carried on in one of the districts for the last three years. The question of a form of correspondence instruction which would not be too lengthy or complicated for the men to take up at once was carefully considered by the company.

A meeting of all the employees in the New Jersey division was held in Newark to determine the value of this form of instruction for practical telephone men. This was well attended and great interest at that time was shown in the question at issue, but it was found that the men lagged in their work on account of the length of the primary work.

When it was found that correspondence instruction was out of the question a different method was eagerly looked for. The success of black-board exercises in the one district mentioned above brought the question of a special instructor to the attention of the company.

The result of the efforts of Mr. Brown

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in this innovation will be watched with great interest. The classes meet in the evening at 7.30 P. M., and the lecture and explanation of diagrams and apparatus closes about 10 P. M. The time of the instructor is devoted entirely to the preparation of lectures and material for use in connection with the classes, which are held every night in the week except Sunday.

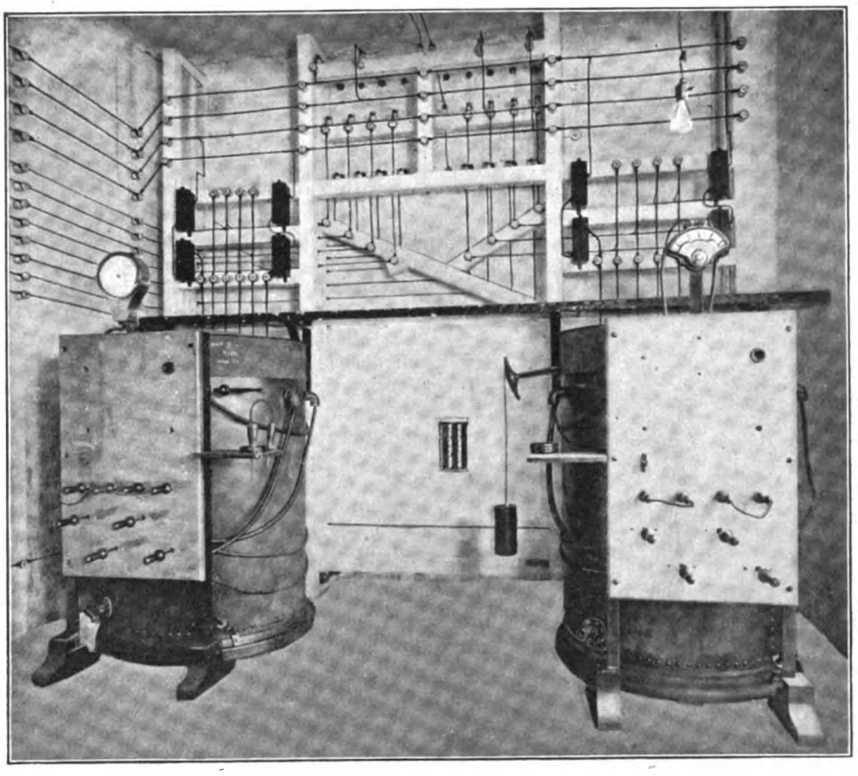
## THE SERIES ALTERNATING CURRENT ARC SYSTEM IN HARTFORD.

As has been pointed out in the convention paper by Prof. W. L. Robb, reprinted on another page, the Hartford Electric Light Company has put into extensive use the series alternating current arc lamp of the General Electric Company, supplied with current from special transformers designed to give constant current from their secondaries, their primaries being supplied with constant potential.

The Hartford Company put in one 30-light transformer of this kind in April, 1898, and followed it with the first 100-light transformer in October of the same year. The 30-lighter has now been superseded and of the larger size there are now 6 in active service, to be followed by one more which has already been ordered. The company has in service altogether some 1550 arc lamps and, as pointed out in the paper referred to above, all of these within the direct current three-wire district, whether used for commercial or street lighting purposes, are constant potential direct-current arcs run from the underground mains. Outside of and generally surrounding this district is another in which all the incandescent lamps, motors and arcs, either street or commercial, are supplied from alternating current transformers, generally on secondary three-wire networks. There remain, however, a certain number of street arc lamps which cannot be reached by either of these constant potential systems, and which were originally supplied by series arc machines. It was for these lamps that the constant current transformers have been installed in order to do away with the small series arc machines with their well known disadvantages.

The arcs are all of the enclosed type, as are all of the arcs supplied from constant potential circuits, and are given 400 actual watts each, which the company estimates gives fully as good, if not better, lighting than the old naked direct current series arcs which its contract with the city specifies should be given 7 amperes at 45 volts each. Of this 400 watts practically all is usefully absorbed in the arc itself, there being no need of a reactive coil as in constant potential work. The direct current constant potential arcs supplied by the same company are given 440 watts between terminals, of which about 140 watts is used up in the series resistance, giving only 300 watts to the arc. The constant potential alternating current arcs are given 500 real watts across the terminals, or about 400 at the arc.

The plans of the company for the future contemplate the extension of the three-wire alternating interconnected distribution network as the residence and other scattered incandescent lighting load increases, and the change of all street arcs to the constant potential type as fast as the network reaches them. The series alternating system will be retained for the outlying lights out of reach of the network only and it is estimated that the present equipment of series transformers will carry these indefinitely, all growth of business being taken up by the extension of the constant potential network, the series lines being gradually crowded out further and further as the city enlarges.



A CONSTANT CURRENT TRANSFORMER SUB-STATION.

The 6 series transformers are located in pairs at three different points, one the battery sub-station and the other two small 10x10 brick transformer stations which do not require attention. A view of the interior of one of these is shown on this page. The two transformers of each pair are connected respectively across the two phases of the two-phase 2400-volt 60-cycle network, balancing the load. The construction of the transformers is of great interest. The principle of regulation is the well known repulsion effect and its application to this purpose is broadly patented by Prof. Elihu Thomson.

Each machine is enclosed in a cylindrical tank, about which a chance remark made by one of the Hartford Electric Light Company's employees when the first one arrived upon the scene, has given the whole scheme a nickname which will probably always cling to it—the "tub" system. These tanks were originally made of boiler iron riveted up, but it has been found impossible to keep these tight against the transil oil which is used for insulation, and the new ones will be made of cast-iron.

In the interior is a transformer of the shell type, with a long, central, vertical core rising the whole length of the tank or tub, surrounded by the primary and secondary coils and with a magnetic circuit closed by return paths outside of them. The primary is made up of two independent coils, one fixed at the top and the other at the bottom of the tub. The secondary is similarly made up of two coils which are free to float up and down in the oil. These two are connected with each other by chains and levers in such a way that as one rises the other falls. They may approach into contact with each other at the middle of the tank or from this position one may rise toward the primary coil at the top while the other falls toward the primary coil at the bottom. Connected with the chains by which they are balanced is a lever which extends outwardly from the top of the oil tank and carries depending from its outer end a heavy adjustable weight. This weight tends to force the two secondary coils respectively toward the two primary coils. When the machine is in operation the currents induced in the secondary react upon those in the primary and tend to force the coils apart, which force is balanced for normal current by the adjustable weight outside

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of the case. If the resistance of the secondary circuit falls due to the cutting out of lamps, the current increases slightly, increasing the repulsion effect, and the secondary is pushed further away from the primary, giving a chance for increased magnetic leakage between the primary and secondary, which reduces the e. m. f. in the secondary, bringing the current down to practically normal, even with wide changes of resistance. The regulation obtained is adjustable by means of a cam-shaped segment which can be moved on the outer end of the weighted lever and very accurate results can be obtained. Recording voltmeter charts show that the current will not vary during the night between wider limits than 6¼ and 6½ amperes, which is as good a result as can be obtained from series arc machines.

The two coils of the secondaries of these 100-light transformers are run on the multi-circuit principle, with 50 lamps in each of the two circuits, and the switching panels for controlling these are shown in the view above mentioned. As the secondary voltage is considerably higher than the primary and the machine delivers the maximum voltage on open circuit, the lines are always shut down by opening the primaries. In starting, the secondary is short-circuited, the short-circuiting plug being afterwards removed. The high voltage gives arcs of considerable length, but these are minimized by the use of a hard rubber sleeve which springs back around the plugs on pulling them out, such as is used with Brush switchboards. The primaries are protected by D. & W. enclosed fuses, two in series with each transformer. Each transformer house contains one Bristol recording ammeter, which is plugged from one circuit into the other by the inspector when he makes his rounds, thus giving a record of each visit to the house. The transformer cases are carefully grounded to prevent any risk of shock from the high voltage.

The Hartford Electric Light Company has, besides the arcs mentioned, 48,000 incandescent lights connected up and 1900 h. p. capacity in motors, a considerable load for a place the size of Hartford, which is due to the company's low rates for current and the satisfactory character of the service.

The present hydraulic equipment is therefore rapidly being outgrown and the company has commenced work on a new power station on the Farmington River, two miles above the present one. Here an additional fall of 31 ft. will be obtained, giving more power than that obtained from the present station, where the fall is only 23 ft. The equipment will differ considerably from the pioneer belted plant at the older station, and will consist of two pairs of Stillwell-Bierce horizontal turbines, direct coupled to two 750-kw. Westinghouse alternators. The current will be carried to Hartford on an aluminum line. The location of the power house is almost ideal so far as topographical conditions are concerned—the river coming through a narrow gorge with rock walls which can be dammed at very small expense. The dam and power house foundations will be of concrete, similar to those at Mechanicsville. The work is being done by the Engineering Contract Company. It is expected that the new power house will be ready for service by October 1st to help out with this year's winter load.

## A COMPARISON OF THE ECONOMY OF TWO ARC LIGHT SYSTEMS.

The earnest desire of many central station owners operating alternating current and series arc machinery to throw their whole load on to one type of generators has developed up to the present time two practical commercial methods of supplying series arc circuits with power from the alternating current machines. One of these, which has been in more or less use for two years, is the combination of an induction or synchronous motor with ordinary direct current series machines, and the other, which has only come into notice within the last few months, but has excited a remarkable amount of attention during that time, is the series alternating current enclosed arc system of the General Electric Company. Much has been written upon this subject and considerable will be found upon other pages of this paper, but little has been said in public print about that important feature, the financial outlay and income. To give an approximate idea of the dollars and cents involved, expressed as a comparison of the outlay for and economy of two systems of supplying arc lamps from a. c. mains, a representative case will be developed as follows:

Let an existing central station be assumed to have sufficient alternating current machinery to operate its arc load with either motors or series alternating system, and let it be assumed that the station has in service two old-style arc machines running 200 open arc lamps, which load it is desired to throw upon the alternators. Considering first the investment necessary for the new equipment, the following valuations may be given in round numbers:

| | |
|---|---|
| Approximate cost of a 150 h. p. motor | $2,000 |
| Inventory value of two old arc machines | 1,000 |
| Inventory value of 200 old open arc lamps | 1,000 |
| Total investment on motor dynamo plan | $4,000 |

While of course the series arc system has not settled down to standard list prices, and on the sales that have already been made allowances must be granted for the high first cost of new appartus and also for introduction rates, the approximate cost of 200 series alternating lamps with the transformers to supply them at 60 cycles can be put down in round numbers as $6,000.

Thus, if the two old arc machines and the old open lamps can be disposed of at the rates mentioned above, the laternating arcs would represent an original outlay of $2,000 more than the motor driven arrangement. Figuring interest at six per cent. and depreciation at ten per cent. in both cases, the fixed charges of the alternating arcs would be $320 per year more than those of the motor driven plant.

The comparative efficiencies of the two systems at full load, which is the normal condition of street service, may also be taken up somewhat as follows:

| | |
|---|---|
| Efficiency of a 150 h. p. alternating current motor, approximately | 92% |
| Efficiency of old arc machines, approximately | 76% |
| Total efficiency of motor driven sets, approximately | 70% |
| Efficiency of 100 light alternating series transformers | 95% |

If the open arcs are what is nominally known as 1200 candle power each, they consume about 350 watts per lamp. With an efficiency of 70 per cent. the motor would require approximiately 500 watts per lamp from the alternating current bus bars to drive the arc line.

The comparative economy of the two systems will of course depend largely upon the amount of power given to the alternating arcs, which should be such as to give the same amount of light as the 1200 c. p. open lamps. The number of watts in an alternating enclosed arc necessary to do this cannot be definitely stated, but is largely a matter of judgment. Assuming, however, that the central station manager considers it sufficient to give 400 actual watts in place of the 350 given the direct-current lamps, the series transformer with an efficiency of 95 per cent., will require from the alternating current lines 421 watts per lamp. This number of watts would probably not give as high a mean spherical candle power as the open lamps assumed, but owing to the better diffusion of the light may give just as satisfactory illumination. This figure was taken because it is the number of watts given the lamps already put in use, although it is probably hardly a fair substitute for the normal 1200-c. p. open lamp and a higher wattage might be necessary. However, the figure taken shows a saving at the alternating current mains of 80 watts per lamp in favor of the alternating arc. Figuring a daily operation of 200 lamps 11 hours for 365 days in the year, at 1c. per kilowatt-hour, the saving in power annually would be about $600.

It would be well, however, to discount this considerably owing to the small amount of energy given to the arc in the above calculation, and it probably should come down to a figure which would about balance the difference in fixed charges in favor of the direct current arcs, leaving the advisability of one system or the other to depend largely upon the relative cost of trimming, attendance, repairs and operation.

The maintenance cost of the 200 open arc lamps may be estimated at, in round numbers, about $11.50 per lamp per year for trimming and carbons, this being a fair figure with 12-in. carbons at $6 per 1000, 7-in. carbons at $3.50 per 1000, and one man trimming 100 lamps at $2 per day. The enclosed arcs with carbons at $21 per 1000 and a life of 80 hours, one carbon being used per trim, and with in-

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ner globes at $.18 each and a life of 600 hours, would show a cost of:

| | |
|---|---|
| Carbons per lamp per year..... | $1.35 |
| Inner globes per lamp per year..... | 1.20 |
| Trimming per lamp per year..... | 1.65 |
| Total per lamp per year..... | $4.20 |

There is thus shown a saving of something over $7 per lamp per year in favor of the alternating enclosed arcs. This saving, of course, is not so much due to the use of alternating current at the arcs as to the use of enclosed arcs, and may be obtained just as well with enclosed arcs on the direct current series system with motor driven machines.

Another element, however, which is very hard to reduce to dollars and cents in any typical case, but which each central station manager can estimate for himself according to the local conditions, is the reduced cost of attendance and repairs, the alternating arc system requiring no motor and arc dynamos, but in their place only a transformer which may be located at the generating station or, if economy of copper so dictates, may be located in a small sub-station. The amount of floor space required is considerably less and the machine much less likely to get out of order and require repairs, rewinding, or give trouble from breakage of mechanical parts or insulation.

The general conclusion of the whole matter is that having open direct current series arc lamps and machines for supplying them—the alternating arc system will show a first cost somewhat greater than the motor driven arrangement, which amount will be repaid by its greater economy of power. The enclosed arc, as usual, shows an economy of trimming over the open and the alternating system shows a general advantage over the motor driven set in the reduced attendance and trouble.

# National Electric Light Convention.

The twenty-second annual meeting of the National Electric Light Association held in New York City, May 23d, 24th and 25th, differed very little from its immediate predecessors, the association apparently having reached years of discretion and settled down to a stable basis. This meeting, like that held three years before in the same city, was in the same building with the electrical exhibition, although the latter was unfortunately not this year as extensive, interesting or enthusiastic as the first, and up to the present the best of all New York electrical exhibitions, that was held in the Grand Central Palace three years ago.

The papers presented, most of which are reprinted in part below, illustrate the application of scientific and engineering methods to all departments of the central station business, including even the financial. It is a remarkable fact that the precise methods of thought, cultivated by the study of mathematics and the practice of engineering, have carried the business and financial departments of the central station industry to a much higher plane of perfection than the corresponding departments of any other industry.

A perusal of the following extracts from papers presented will, it is believed, illustrate this observation.

The morning session of Tuesday, May 23d, was opened as usual by the address of President Young, which reviewed the remarkable advance of electrical engineering during the last decade and particularly the development of the enormous installations now proceeding in the Greater New York. The address was followed by the following paper presented by Mr. W. S. Barstow on

### A LOCAL TRANSMISSION SYSTEM—DEVELOPMENT AND OPERATION.

The plan of the Edison Company, of Brooklyn, as originally outlined in 1896, and as finally completed in 1897, provided for the use of a three-phase, 25-cycle, 6,600-volt system, three-phase because its use was for transmission purposes only, 25-cycle because of the ease at this frequency of station operation, transmission and transformation, and a pressure of 6,600 volts because this was sufficient, with the price of copper at 18 cents, to reach economically all parts of the greater city and suburbs.

The main station, located on the water front at Bay Ridge, is called the Union Station, because it generates a current which unites all systems hitherto separately operated. From this point high-tension feeders, the majority under ground, extend to ten sub-stations, where the energy is received, transformed and distributed.

In the designing of a switchboard for high-pressure work special attention should be paid to the simplicity of arrangement and contents of such board, as the fewer the devices, the better for the reliability and success of the system. The conditions of the operation of a high-tension multiphase system, when used for distributing purposes to sub-stations, differ considerably from the requirements of a primary station with a simple distributing system. This difference lies mainly in the fact that feeder regulation in the high-tension multiphase transmission system can be almost entirely dispensed with, the sub-stations doing the necessary regulating for the energy as required by the customers. Therefore, the important requirement in the multiphase transmission station becomes simply the positive controlling of the energy generated at the machines, with possibly the operating of one or two sets of auxiliary bus bars. For the controlling of this generated energy, switches, capable of breaking a full and overload current, should be placed between the generators and the bus bars, and between each set of bus bars. This requirement will be found to be imperative. In Brooklyn these switches are operated by electrically controlled pneumatic attachment, used by the Pennsylvania Railroad system in their large switch yards. In all cases these have been positive and satisfactory in action. It is the present intention to control the interlocking circuit by a device dependent upon the synchronizing of the current, so that two machines or sets of bus bars cannot in any way be accidentally connected when out of phase. The switch itself, breaking under oil, is not in any way complicated, and has satisfactorily withstood the test of capacity and time. These main switches, placed as above stated, are the only ones in the station which will break under overload and pressure of 7000 volts, with the exception of the emergency switches. These emergency switches are plain pivoted copper




ONE OF THE ELECTRO-PNEUMATIC SWITCHES IN BROOKLYN.

blades, with a fuse in multiple, and are to be pulled only in a case of last resort in event of any accident happening to the switchboard itself.

Distribution from a high-tension multiphase plant is an important problem, particularly as regards the underground and overhead conductor systems. In Brooklyn, with a view of securing the best service on feeders, which must necessarily be overhead, heavy chestnut poles of about 45 to 50 ft. in height, and about 90 ft. apart, were used. The poles are fitted with special six-pin cross-arms. On the outside insulators of the top cross-arm are attached barbed galvanized-iron wires, which are grounded at every fourth pole. The second cross-arm carries the feeders in duplicate, three on each side of the pole. With three conductors on a hori-

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zontal cross-arm, we are able to reduce inductive effects by transpositions, which, at low frequency, are satisfactory. The insulators are of glass, of the double or triple-petticoat type, and during the two years they have been in use, no defects whatever have developed. The line is carried entirely over all obstructions, in some cases it being necessary to use 70-ft. poles. More or less trouble has been experienced with lightning, and the heaviest trunk lines have been equipped with lightning arresters.

The style of conduit used in Brooklyn may be termed a closed system, owing to the fact that it has been the endeavor to keep the entire conduit system as water-tight and dry as possible. A vitrified tile duct is used, with water-tight joints, and the brick manholes are of double construction, filled in with tar, and built on heavy concrete foundations resting upon creosoted timbers. The covers of the manholes are patterned after the Edison ten-stub junction-box top. The inside cover is provided with a rubber gasket, and held in place by bolts. The outside is simply a heavy cover, acting as a mechanical protection to the inside one. The conduit system is connected to the unused brick stacks of the stations in which steam has been removed and transforming apparatus substituted. In addition, a blower is operated at the Bay Ridge station. The movement of air through such a large system, composed of some 100 miles of duct, is very slow, and yet it is sufficient to keep the system in good condition.

The reason for the adoption of a tile conduit as moisture-proof as possible was in the main on account of electrolysis. In making preliminary tests along the proposed line of conduit it was found that the pressure from metallic substances to ground varied from 10 volts negative to 26 volts positive. Thus it would only be a question of time before the heaviest lead cover would be totally destroyed. It was also found that the only solution was to make the lead cover of the cable negative to ground throughout the entire system. This demanded that all stray currents should always flow to the lead cover and should never leave it. Such a condition required that the lead covering of all the cables should be connected to the negative bus bars of the railroad power houses by insulated conductors of low resistance.

The question of mechanical covering for the cable itself depends upon the nature of insulation, the liability to electrolytic action or the effect of gases. Paper cables must necessarily be covered by lead or other moisture-proof material, the life of the cable depending upon such moisture-proof covering. Rubber cables, when subject to electrolysis, can be protected by a covering of water-proof asbestos surrounded by a very heavy braided covering, put tight and thoroughly saturated with compound. In Brooklyn all cables, whether rubber or paper insulation, are covered, wherever they pass through manholes, with heavy asbestos tape. In case a burn-out occurs on a cable with 1000 or 2000 kw. behind it, such an arc and heat is developed that injury is apt to result to adjacent cables, and it was found that by protecting each cable in this way further damage has been prevented.

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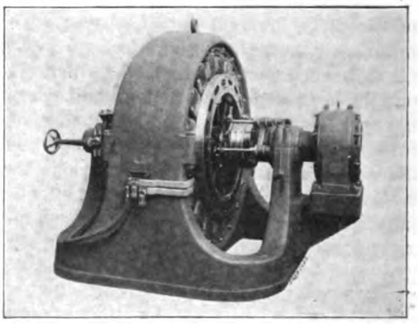
During the afternoon session the only paper presented was that of Prof. W. L. Robb on

ROTARY TRANSFORMERS AND STORAGE BATTERIES AS RELATED TO LONG-DISTANCE TRANSMISSION.

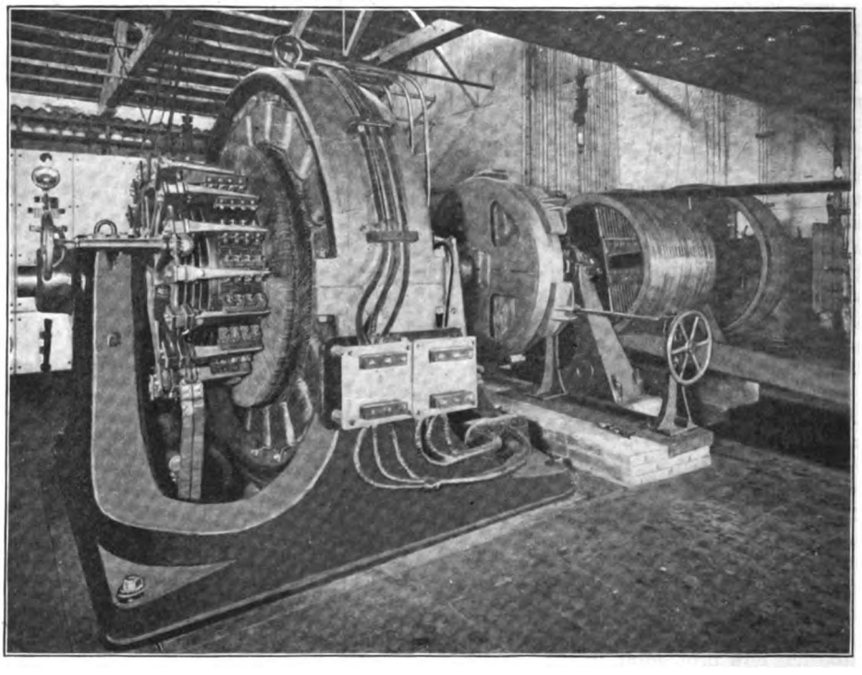
The main source of power is water power on the Farmington River, approximately eleven miles from Hartford. The water power at present developed is capable, under the most favorable conditions, of delivering at the switchboard in Hartford about 1200 electrical horse-power. The power is generated by two 600-kw. 60-cycle alternators and transmitted to Hartford on the three-phase system under 10,000 volts pressure.

The water power is supplemented by an auxiliary steam plant in Hartford, consisting of two compound-condensing Cooper-Corliss engines, having a combined capacity of 1600 horse-power. These engines supply the power to operate one 600-kw. alternator and one 400-kw. rotary transformer, so arranged that it can be connected with engines and operated as a direct or alternating-current generator. This rotary is so operated whenever, owing to low water or repairs on the transmission line, the supply of alternating current is insufficient for the alternating-current load and all the rotary transformers.

Two systems of distribution are used. In the central portion of the city the distribution is on the three-wire, 220-volt, direct-current system. This part of the service is practically all underground. The feeders are lead-covered cables drawn in cement-lined ducts. The distribution is in part by Edison tubes and in part by lead-covered cables drawn in ducts. Outside the central portion of the city the feeders are supplied with two-phase alternating current under 2400 volts pressure, and the distribution is, in general, on three-wire, 220-volt systems, supplied from ten or twenty kw. transformers, although a few smaller transformers are still in service. This service is in part under ground, but, in general, overhead. Constant-potential, inclosed-arc lamps, incandescent lamps and motors, in the case of both alternating and direct currents, are operated on the same three-wire system. All the commercial arc lamps, whether on the direct or alternating system, are of the constant-potential, inclosed type, as are also the street lamps in streets in which there is a three-wire system. In other streets the street lamps are of the series alternating-current, in-



ONE OF THE 250 KW. CONVERTERS, WITH STARTING MOTOR.



THE 400 KW. CONVERTER, SHOWING CLUTCH AND BELT BY WHICH THE MACHINE IS USED AS A GENERATOR OR MOTOR.

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closed-arc type, and are operated from constant-current transformers.

Three rotary transformers supply direct current to the three-wire, direct-current system. One, mentioned above, has a capacity of 400 kw., and is located at the steam plant. Two have a capacity of 250 kw. each, and are located in a battery sub-station which is situated in the very heart of the business section of the city, and about three-quarters of a mile from the steam plant. The storage battery has a capacity of 2500 horse-power hours at a five hour rate of discharge. All three rotaries and the battery supply currents to the same three-wire system.

The three alternators are always operated in parallel. At least one rotary transformer and storage battery are always connected to the three-wire, direct-current system. The direct and alternating-current systems are consequently interlocked, and the whole plant, including alternators, rotary transformers and battery, is practically operated in parallel.

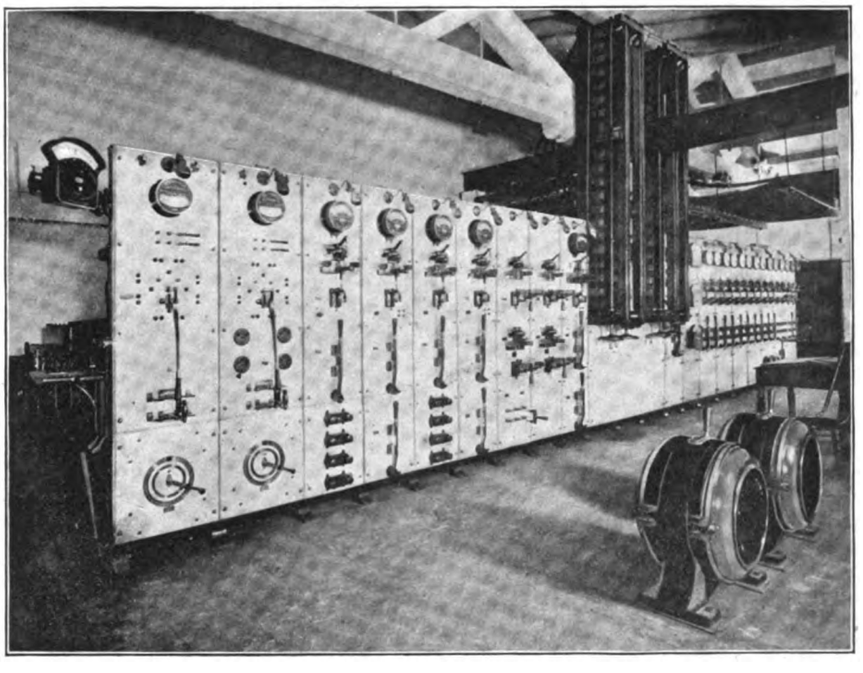
The rotary transformers are of two-phase type, and are so designed that by cutting in or out turns of the primary of the transformers the voltage of the rotaries may be varied betwen 230 and 360 volts. This wide range of voltage is necessitated by the fact that the rotaries are at times run directly on the line, and at other times used in charging the battery, frequently at high charging rates. This wide range of voltage that can be obtained from the rotary does away with the boosters, otherwise necessary in charging.

The rotary transformers are two-wire, and simply supply the current to the outside wires of the three-wire system. The neutral wire is connected with the middle point of the secondaries of the two transformers. This point is always midway, as regards electric pressure, between the two terminals of the rotary transformer.

The three alternators, one operated by steam and the other two operated by water power at a distance of 11 miles from the first, have been continuously run parallel during the past thee years. No difficulty whatever has been found in this method of operation.

The operation of the rotary converters has not been so simple a matter. At the outset there was excessive sparking at the commutator. This sparking was soon found to depend very largely on the variety of brushes used. It was found that a very soft carbon brush gave the best results, but without special treatment of the brushes, sparking, although diminished, is still excessive. The method of treating the brushes suggested by our superintendent, Mr. Rollins, was tried and found effective. The carbon brushes are first raised to a red heat, and then plunged in ordinary lubricating oil and allowed to cool. When brushes treated in this manner were used all vicious sparking was stopped, and in this particular the converters ran as smoothly as direct-current generators of the best type. At the outset, in operating the rotaries, considerable difficulty was met with in preventing pumping when the engines were supplying power to the system. This pumping could be traced to the variation in the angular speed of the engines, and when the water power alone was supplying the power there was little, if any, pumping. It was found that this tendency to pumping could be checked by varying the field excitation of the rotary transformers or by temporarily throwing a portion of the load on the storage battery. Only once in the past three years has the pumping been such as to cause any serious interruption. The switchboard at the sub-station was originally arranged to give the greatest possible flexibility in operation. Both rotaries could be run in multiple, feeding into the line, and the excess of current used to charge the battery; or one rotary could be run on the line and the second rotary used to charge the battery independently. This last method of operation was found impracticable. Under this condition the pumping would immediately begin, and it necessitated giving up this method of operation. Notwithstanding the above-mentioned difficulties, when a year ago it was decided to increase the direct-current machinery, we had gained sufficient confidence in the rotary system to purchase a 400 kw. rotary rather than a direct-current generator.

The third rotary, when tested, proved to be free from any tendency toward pumping, either when operated from the steam plant or from the water power, and was in every way as nearly perfect as a machine could be. However, when thrown on the line with the two older rotaries, they immediately began pumping, and it was found impossible to run the three rotaries together. The pumping in a rotary system seems to be cumulative; it is very easy to stop it if the proper remedy is applied as soon as the first tendency to pump is noticed. If allowed to go on it quickly gets beyond control. The impossibility of running the three rotaries together necessitated some change. The Westinghouse Company's engineers maintained that the corrective device could be applied with equal effect to any one of the three rotaries. Copper strips were attached to the pole-pieces of the 400 kw. rotary. This rotary, of itself, was all right, but the developing of any tendency of the system towards pumping was entirely overcome by means of these copper strips. The system now works perfectly, whether operated by steam or water power. Even under the trying conditions of running the rotaries under different voltages, two feeding directly into the line and the third independently charging the battery, no trouble with pumping is experienced. In all other respects the rotary transformers have been all that could be asked for; they have run practically continuously night and day for nearly three years and have had practically no repairs, the commutators simply being turned down once or twice a year.



THE SWITCHBOARD OF THE HARTFORD ROTARY AND BATTERY STATION.

The transformer and battery station is operated by three men; the superintendent, an expert in the care of batteries, and two switchboard attendants. The labor in caring for a station of this output is a minimum.

To sum the matter up, my Hartford experience has convinced me that the most satisfactory method of supplying electric energy over a considerable area is from a central power station generating alternating current; the current being distributed to rotary and battery sub-station of high voltage, and the energy locally distributed on the three-wire, direct-current system, except in outlying districts where it will prove most advantageous to distribute on the alternating current system.

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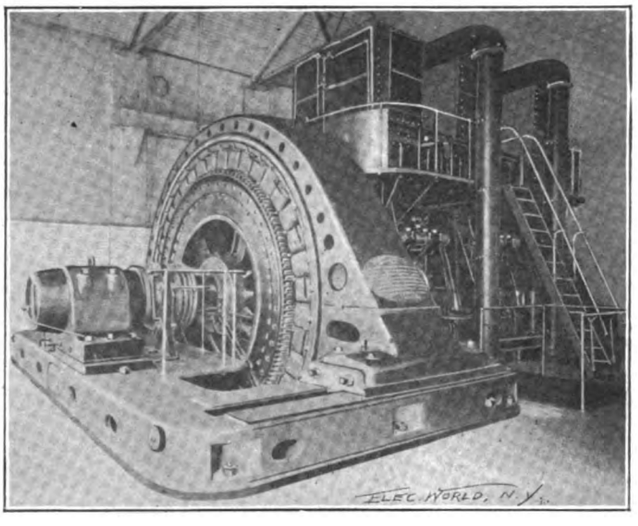
The first paper presented at the session held on Wednesday morning was by Herbert A. Wagner on the following subject:

SINGLE-PHASE DISTRIBUTION.

Probably the best example of pure single phase distribution on a large scale is furnished by the Missouri-Edison Electric Company, of St. Louis, and I can best show its possibilities by describing the results obtained by this company.

In a large portion of the city the usual system of individual transformers for every customer or adjacent customers is used. The current for these transformers is supplied by overhead feeders and distributed over high-tension overhead mains. In some districts one transformer is used to supply current for an entire block by means of three-wire low tension secondary mains.

The principal business portion of the city is now supplied by underground conductors, covering a district of forty miles of streets. A low tension Edison three-wire network of mains is used throughout this district, and these mains are supplied by high tension feeders, each of which terminates in a transformer of the same capacity as the feeder. Pressure wires run from the mains near the terminal of each transformer back to the station. Each feeder has a regulator or booster at the station.




ONE OF THE LARGE GENERATORS OF THE MISSOURI-EDISON COMPANY IN ST. LOUIS.

From this network of three-wire single phase alternating current mains current is furnished for incandescent lamps, arc lamps and motors. There are at present about 1,000 h.p. of single phase motors in operation, varying in size from ½ h.p. to 25 h.p. Many of these have replaced direct current 500-volt motors, and there is not one that is not giving perfect satisfaction. Current is charged for entirely by meter.

The most novel feature of this system is the transformer and the method of making it practically a part of the feeder to which its drop is added and is cared for by the feeder regulator at the station. The pressure wires indicate the pressure on the secondary mains which can be kept constant, however much the drop in feeder and transformer may vary.

The transformers were designed for remarkably high average efficiency, and actually show the highest efficiency at about one-quarter load. The specifications for these transformers limited the iron loss to 250 watts, the copper loss at full load to 3200 watts, and the regulation to 4 per cent. Thirty of these, of 110 kw. capacity each, are in service on as many feeders. They all run slightly under the specified losses.

The feeder regulators at the station make it possible not only to regulate the pressure with the greatest precision, but to divide the load between the feeders and their transformers in any way desired. By slightly lowering the pressure on one feeder, and slightly raising it on an adjacent one, a large proportion or all of the load of the first can be transferred to the second without sensibly altering the pressure on the mains. This operation is almost identical to that of dividing the load between two direct current generators running in parallel. All feeders can be kept almost equally loaded in this way if desired.

It is our custom to plot quite frequently curves, showing loads on all feeders in a district, for the purpose, among others, of establishing the best pressure wire to adopt for a period as standard for general regulation. The bus bar pressure is always regulated by the indications of this standard pressure wire, and the individual feeders whose pressure departs from the standard, up or down, are regulated independently, from time to time, by their own regulators.

All feeders are provided with fuses at the station end, and the secondary terminals of each transformer are led into junction boxes provided with copper fuses. These fuses are intended to protect the rest of the system in case of any defect development in a feeder or its transformer.

The method of eliminating the effect of transformer drop by making it a part of the feeder renders it possible to regulate, with a system of interconnected mains and the use of pressure wires, as closely as in a direct current system; and the use of individual feeder regulators enables the pressure to be adjusted with the greatest precision.

The ratio of current delivered to customers as shown by customers' meters to the actual station output as shown by the station wattmeters, while not an exact measure of the distribution efficiency, owing to the losses in the customers' meters and their failure to record properly at small loads, is nevertheless a good indication for relative comparison. On the single-phase underground distribution system described, this ratio of customers' meter readings to station output reaches 86 2-10 per cent. The meters used on customers' premises are the most recent type of induction wattmeters. The station meters are of the Thomson recording type, and these are carefully checked by the half-hourly records of station indicating wattmeters, both being frequently calibrated. While this figure may be the highest on record it has been obtained with such great care month after month that I feel great confidence in its accuracy. The greater portion of the overhead distribution of this same company is of the usual form with individual transformers to each customer as already stated. A large portion of the current supplied in this way is used in residences, and consequently the load factor is very low. The meters used in this work are recording ampere meters which let a considerable amount of current slip by unrecorded with light loads. The transformers are all of modern design and of high efficiency for their size. It may surprise you, however, when I state that the ratio of customers' meter readings to station output in this overhead distribution is only 48 3-10 per cent. I am also as positive of the accuracy of this low figure as of that of the remarkably high one for the underground system.

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In the afternoon session of Wednesday the first paper presented was that of Mr. E. A. Leslie on

NOTES ON UNDERGROUND DISTRIBUTION OF TWO-PHASE CURRENT IN NEW YORK CITY.

The company with which I have the honor to be connected decided about two years ago to substitute two-phase for single-phase distribution, but one of the very first difficulties encountered was the subway situation. The trouble is that with so many occupants of the conduits it is not practicable to provide room under ground for junction boxes, large transformers and other apparatus necessary for a reliable system of meshed conductors, without which no company can, in my opinion, hope to compete to advantage with direct-current distribution.

Without junction boxes we were afraid to mesh our conductors, and for this reason and the possibility of patent complications we adopted the four-wire method.

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consisting of two circuits, the currents thereon differing ninety degrees in phase. These circuits are operated practically the same as single-phase circuits, except that their distributing mains necessarily parallel each other, and, therefore, while with single-phase distribution we formerly employed but one distributing main in any given section, we now employ two. This is, of course, necessary to enable us to supply current for power purposes in units of 5 h.p. or over; but it also has this decided advantage, that it enables us to provide, at slight expense, a second source of supply for lighting and single-phase motors, in large and important installations, where an interruption of considerable duration might result in serious consequences. For this purpose a special non-arcing switch (Fig. 2) is provided, making it perfectly safe for any one to throw over from one circuit to the other the heaviest loads our largest customers are ever likely to use. These loads sometimes reach as much as 100 kw., but as our generators, ranging in capacity from 300 to 450 kw. each, all run in parallel, and the circuits consequently are all fed from common bus bars, the unbalancing effect of such switching over is rarely felt to an annoying degree. Of course, it is always desirable to preserve a fairly good balance, and these switches are frequently employed for this very purpose.

The most serious difficulty encountered was the switchboard and regulating apparatus. Formerly our generators were small, not exceeding 60 kw. each, and as they were run independently, the number of lamps connected on each circuit was necessarily governed by the capacity of the machine, and the regulation of the pressure was usually effected on the machine itself. The loads rarely exceeded 25 primary amperes, and could be switched from one generator to another without serious danger of arcing or practical interruption to the circuit. With

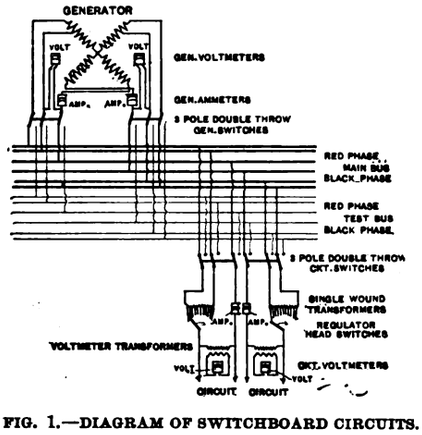



FIG. 1.—DIAGRAM OF SWITCHBOARD CIRCUITS.

the adoption of the two-phase system, however, generators of from 300 to 450 kw. were substituted and run in parallel; the number of circuits was largely reduced, and the loads on those remaining were increased to 100 amperes. We quickly found that we could not throw loads of 100 amperes at a pressure of 2,500 volts on the ordinary switchboard without dangerous arcing and annoying interruptions to lights and motors. Neither could we satisfactorily regulate our pressure. In order, therefore, to secure safety and convenience, and at the same time control the pressure of each circuit independently of the others, it became necessary to adopt a special form of switchboard and regulating apparatus, as shown in Fig. 1, which was devised by Mr. W. F. Wells, the assistant general manager of the Manhattan Electric Light Company, of this city, and a brief description of which may be of interest.

We brought out a third lead from the stator armatures of our generators, as shown in sketch, so as to give us 10 per cent. of the total voltage; that is, with the machine generating 2,500 volts on each phase, we should have between leads Nos. 1 and 2, 250 volts; between Nos. 2 and 3, 2,250 volts, and between Nos. 1 and 3, 2,500 volts. The six leads from each machine (three on each phase) are carried through a three-pole, double-throw switch in the switchboard to the 'bus-bars, of which there are two sets of six each, as shown. Ordinarily, but one set

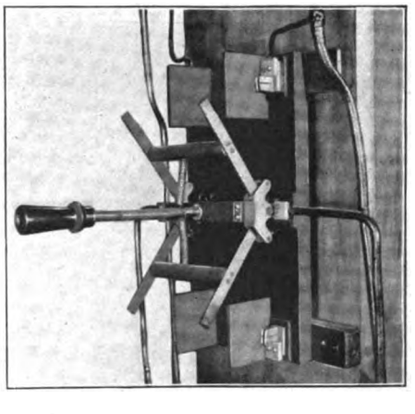


FIG. 2.—NON-ARCING THROW-OVER SWITCH.

of bus bars is used, as the generators are run in parallel, the other set being held for testing or the operation of a circuit singly if desired. The circuits are connected to these bus bars by similar switches. Lead No. 3 from the switch, after passing through an ammeter, goes direct to the circuit. Leads Nos. 1 and 2 are connected to the terminals of a single-wound transformer, sometimes called an "auto-transformer" or "economy coil." This coil has eleven leads brought out, dividing the coil into ten equal parts, each part representing 1 per cent. of the total primary voltage. These eleven leads are carried to an eleven-point switch of the regulator-head type, so that any potential between 90 per cent. and full voltage of the machine (in 1-per-cent steps) may be run on the circuit. We are, therefore, able to keep the station end of the circuit within one-half of 1 per cent.

Plug and cable connections were also added to the board in case greater subdivisions of circuits were needed than could be obtained on the two sets of 'bus-bars. The synchronizing devices and pilot lamps of the machines are connected across the 10-per-cent. coils, and, therefore, switchboard transformers are not required for these purposes. A view of this switchboard is shown in Fig. 4.

TESTING FOR FAULTS.

Notwithstanding the greatest care in the selection of insulation and the most rigid specifications for the guidance of manufacturers, faults will occasionally

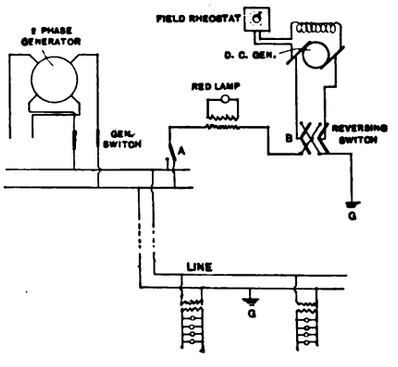



FIG. 3.—METHOD OF LOCATING GROUNDS.

develop in our cables, which are due either to inherent defects or lack of proper mechanical protection. In such cases the necessary interruption to the circuit for purposes of repair is an exceedingly important matter, and, if frequent or long drawn out, will invariably result in loss of prestige and business. Therefore, to facilitate the removal of the fault as much as possible, it was formerly our practice, whenever one of our alternating circuits became earthed, to isolate it from the other circuits by throwing it on the "test" bus in connection with a spare generator and use a device for locating the trouble, which was designed by Superintendent Sparrow, of the Manhattan Company. It includes the apparatus shown in Fig. 3, herewith :

A single-pole, double-throw switch A is attached to the test bus and from the center of this switch a lead is carried through the primary of a transformer which has a red lamp connected across its secondary; then through the ammeter to the diagonally opposite outside poles of a double-throw, double-pole switch B; from the other outside poles a wire is carried to ground. Current is supplied to the center connections of this switch by a small direct-current, shunt-wound generator having a capacity of about 10 amperes at 250 volts, and by means of this reversing switch the current can be sent through the circuit in either direction. In locating trouble the direct-current generator, which is belted to a 5 h.p. motor, is started and the single-throw switch A thrown on either side of the bus. If the red lamp lights up, it indicates that the ground is on the other leg, and the switch is thrown over. The direct current is then brought up to about 7 amperes, and the reversing switch B is thrown about every 15 seconds, which reverses the direction of the direct current flowing through the cable to the ground. The subway workmen then start out with a

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compass and go to a manhole through which the circuit in question passes. If, on laying the compass on the cable, the needle reverses every 15 seconds, they know the ground is farther from the station; if, however, the needle is not affected every 15 seconds, it indicates that the trouble is between the manhole opened and the station, and they then open another manhole nearer the station. In this way they are able, without cutting the cables, to locate the trouble in a section between two manholes or handholes, or possibly in a manhole; whereas prior to the use of this device we were frequently obliged to cut in fifteen or twenty places before locating the fault. In some cases, if the trouble is slight, we are able to repair it without shutting down the circuit, as the men are provided with rubber boots and rubber gloves drawn on over buckskin gloves, and an insulated box to stand upon, and can safely and quickly make a temporary joint that will answer every purpose until such time, say early the next morning, as the circuit can be shut down without detriment to the customers. If, however, the trouble is extensive, the circuit is shut down

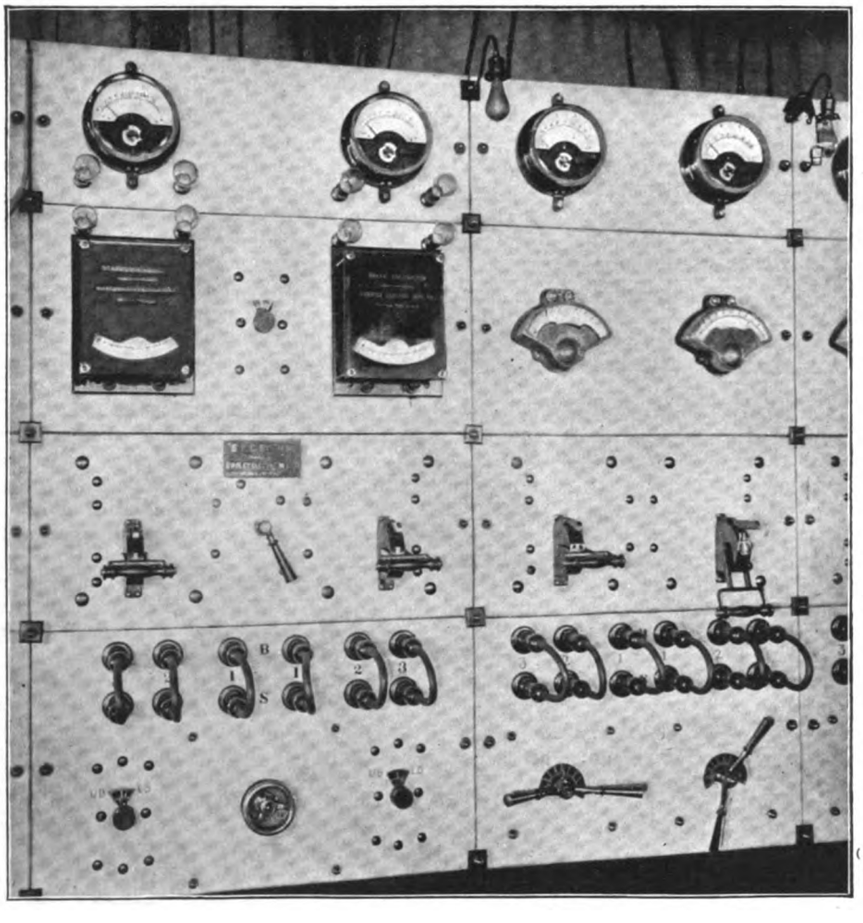


FIG. 4.—ONE MACHINE AND ONE LINE PANEL OF SWITCHBOARD.

at once and the repair made as promptly as circumstances permit.

Unfortunately, however, the subway company objects to the circuit being run, even on an independent generator, while we are locating the trouble, and therefore we now pull the circuit at once and make the test in the same way, except that we use two compasses, as the direct current flows through the primaries of the transformers and tends to mislead the men if they use but one. A compass is placed on each cable, and as long as both needles are similarly affected they know that the trouble is beyond them; when, however, the needles tend to point in opposite directions, they know that they have passed the trouble, and its location is then easily determined.

It is, perhaps, curious to note that when the alternating current is on the circuit the direct current apparently does not flow through the primaries of the transformers. Trouble on series arc circuits is also located in this way, except that not more than about four amperes of current is used, because otherwise the cut-out magnets tend to act and throw the regular lamp magnets in circuit, the resistance of which practically stops the flow of the current.

### TESTING FOR INSULATION RESISTANCE ON LIVE CIRCUITS.

It often happens in running a large number of circuits from a common bus, that phenomena will arise that have a suspicious look and make it desirable to find out which particular circuit or circuits has caused the disturbance. It would have been disastrous to the money-making end of the business if every time something unusual manifested itself we had made a practice of pulling circuit after circuit until the delinquent had been detected, and it therefore became desirable to be able to make reliable insulation tests while the circuits were in actual

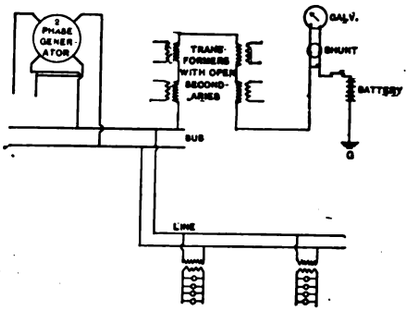



FIG. 5.—METHOD OF MEASURING INSULATION RESISTANCE.

operation. In order to accomplish this, an arrangement of apparatus was devised, such as is shown in Fig. 5, and which is described as follows:

A spare generator is started and connected through its switches to the test bus. From this bus a line is carried through a high-tension switch and then through the primary coils of four transformers in series, the secondaries being left open, as shown in the diagram. This line is then carried through the galvanometer, which is provided with the usual short-circuiting key and shunt; thence it goes to a battery of 100 chloride cells equipped with reversing key, and thence to earth. The transformers used are of the ordinary 2,000-volt type (which is the pressure used on the system), and are of about 2 kw. capacity each, which we have found by experience to be about the right size. The coils being in series, they offer very high inductive resistance to the passage of alternating current, but their resistance is practically nothing when measuring megohms with direct current.

In making the test we first ascertain the insulation resistance of the generator, test bus, leads, etc. The circuit is then thrown on the test bus and tested in the same manner as if it were not connected to a high-tension generator, with the exception that it is not necessary to allow any time for charging or discharging the cable. This is called a "hot" test. The results are the same on testing either leg of the circuit, and the insulation resistance is generally found to be anywhere from 15 per cent. to 75 per cent. lower when tested "hot" than when the circuit is disconnected from the generator and tested in the ordinary way; that is, "cold," although the lower the insulation of the circuit, the closer the two tests appear to agree

When this device was first put into service, and we had convinced ourselves that the readings obtained were really useful, we became impressed with the idea that perhaps we might be able to note the actual effect of the strain of the pressure upon the insulating material surround-

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ing the conductors, and to this end a special set of tests was made.

While the results were too indefinite to be regarded as at all conclusive, they nevertheless point to the fact that the insulation of circuit does depreciate, for the time being, while under the influence of high potentials.

THE USE OF THE TELEPHONE IN UNDERGROUND TESTING.

It has been found by experience that underground circuits, particularly those employed for series arc lighting, need periodical overhauling, otherwise weak spots will accumulate to such an extent as to bring down the total insulation resistance below the standard requirements. At such times a great many galvanometer tests are necessary, and it was found that the work could be done much more quickly if the galvanometer were set up in the station instead of being moved from place to place along the street. The great objection to this, however, was the necessity for frequent communication between the foreman of the subway gang and the tester in charge of the galvanometer, obliging the former to use the public telephones a great many times during the day, which was decidedly inconvenient and involved much loss of valuable time. To overcome this serious objection, Mr. Sparrow and his assistant, Mr. L. A. Jenkins, caused to be constructed a special telephone set for use on underground cables, which works very satisfactorily.

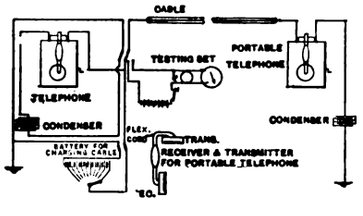



FIG. 6.—TELEPHONE CIRCUIT.

The magnetos, instead of being wound, as ordinarily, for 10,000 ohms, are wound to ring through 50,000 ohms, and a battery is placed inside of the magneto box, the transformer and receiver being mounted on a separate L-shaped piece connected by a flexible cord to the magneto box. The impedance of the series arc circuits, when used for telephoning, is very great, owing to the capacity of the rubber-covered, lead-sheathed cable, and, in order to talk successfully, it was found necessary to use condensers in connection with both telephones. With their use we are able to hold conversation over our longest series arc circuit, which is twelve miles under ground and three miles overhead, and contains 65 lamps. The method is very simple, as may be seen from the accompanying diagram, Fig. 6. The telephone at the station end, except at time of test, is left constantly in circuit. When the subway foreman has completed his arrangements for a test he connects his telephone, one wire to the copper of the cable and the other to the lead sheath; calls up the tester and so advises him. The foreman then disconnects his 'phone, and the tester does likewise, at the same time switching in his galvanometer. The latter then makes his test and throws his telephone back into circuit. After the lapse of three minutes the foreman also reconnects his telephone and calls up to know the result of the test and get further instructions. In this way the work of overhauling and renovating is very much facilitated, and the cost of maintenance and repair sensibly reduced.

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This paper was followed by one presented by Mr. W. L. R. Emmet on

MEANS OF ATTAINING SAFETY IN ELECTRICAL DISTRIBUTION.

With the simplest arrangement of a primary and secondary circuit as they are now generally installed in this country, there is great liability of the existence of dangerous conditions. There are two connections that may be accidentally made; one giving a cross between primary and secondary, either in the transformer or out of it, and the other, a connection of one of the primary leads to ground. The primary voltage being 1,000 and the secondary 100, the making of these connections immediately establishes a potential difference of 1,100 volts between part of the secondary circuit and the ground. This pressure will, as a rule, be too much for the insulation of combination fixtures, and the first indication of trouble is likely to be a fire, if it be not a shock received by someone who happens to establish a circuit through his body between the ground and some lamp socket or other part that is not sufficiently insulated from the secondary circuit. The method of installation described is almost universally adopted wherever alternating currents are being used in this country. It is, in fact, virtually compulsory upon the average station manager, since no established method of overcoming the difficulty is available that does not violate the fire underwriters' rule that all house wiring shall be free from any connection to ground. If this rule is disregarded, we may ground one side of the secondary, which entirely overcomes the difficulty, and which is open to no objection except that the insulation between one side of the secondary and ground is subjected to the voltage of the secondary circuit.

So long as the secondary circuit remains insulated from ground, these dangers will exist. The remedy for the trouble must be either in the permanent connection to ground, which is now prohibited by one of the underwriters' rules, or in the installation of some device by which the secondary is grounded automatically when the emergency arises.

As I have said, the permanent grounding of transformer secondaries is prohibited by the fire underwriters' rules, which prohibition is generally respected throughout the country, so that most secondary circuits are entirely unprotected from the trouble above described. There are, however, some very important exceptions that afford useful examples of the safety of operating secondary circuits with permanent ground connections. I allude to some of the large Edison companies which have recently installed high-tension alternating apparatus to supply power to existing three-wire systems through rotary converters. In a rotary converter the collector rings and commutator connect to the same winding, so that the direct-current leads are as much a part of the transformer secondary system as if they were connected directly to it. Most of these large Edison companies have for years been operating with neutral conductor grounded. This grounding has in most cases first occurred through chance or accident, and the practice has been persevered in, partly because it would be a difficult matter to avoid neutral grounds, and partly because the grounded neutral is, for several reasons, very desirable.

In these cases two rules of the National Board of Fire Underwriters are violated: First, the secondary system to which all house wiring is connected is permanently grounded; and, second, a primary voltage of 6,000 is used, while the underwriters' rules state that house wiring must not be connected to the secondaries of transformers whose primaries receive current at voltages above 3,000. In spite of these violations, the circuits are just as safe as they were before the high-tension power was used, and safer than they were before their neutrals were grounded, although at that time no high-tension apparatus had been installed. Both of these rules should, and in time will, be abandoned; the first, because it leads to danger rather than safety; and the second, because it endeavors to fix an unnecessary barrier to progress. The interests of insurance companies, as well as of users and manufacturers of electrical apparatus, are best served by the introduction of methods which conduce to economy in the broadest sense.

A forcible illustration of the danger of ungrounded secondaries is afforded by a recent occurrence in New Orleans. In a certain residence district, where houses were connected to a system of three-wire alternating mains, a cross caused by wind occurred between one of the main wires and a 2,000-volt primary wire in the same street. The result was that the insulation between wiring and ground was broken down in a large number of houses, the trouble being principally in combination fixtures where conductors were near gas pipes. Fires occurred in twenty houses and several were totally destroyed, among which were some fine residences. The loss was over $200,000. If the neutral of this system of mains had been grounded, this trouble could not have occurred.

The third cause of danger in electrical distribution is arcing through accidental opening of circuits or through failure of circuit-opening devices. Fuses, switches and circuit-breakers are subjects upon

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which a great deal could be said in discussing means of attaining safety. Many of the circuit-opening devices that have been introduced in the past have been capable only of breaking certain definite currents, and incapable of coping with the conditions existing when a very large system is short-circuited. Most of the switchboard devices that are now in use for alternating work are strictly limited in the range of their safe action, and would be valueless on a circuit capable of delivering a large amount of power.

In the past, alternators have been generally used singly and in comparatively small units; the total power that could be delivered to one point being limited to the maximum output of one machine. In many of the installations now being made, numbers of large machines are being run in parallel, and the power that can be delivered at any point is consequently large, and the difficulty of breaking the current that flows in case of short-circuit is correspondingly great.

In the new station of the Metropolitan Railway Company, about 50,000 kw. will be delivered to a single set of bus bars, and from there distributed all over the city. Wherever a sub-station or other installation is connected to these lines, means must be provided by which the circuit can be broken instantly in case a short-circuit occurs. The power of this station is generated and distributed at 6,000 volts, and the loss in lines will be small, so that the violence of a short-circuit in a sub-station will be almost as great as if it were on the main bus bars.

We have recently done a good deal of work on circuit-opening devices for such heavy duty. One of the principal troubles in such work is the difficulty of making experiments. We have a testing outfit at Mechanicville with which we can get from 300 to 400 amperes at 15,000 volts with an inductive load, and at Niagara Falls I have tested some devices with 700 amperes and 13,000 volts and a highly inductive load, the voltage rising to 18,000 when the circuit was opened. In comparison with past experiences these conditions seem heavy, but they are light when compared to those which must be met in some plants that are now being installed.

There is, of course, a limit to the capacity of every circuit-opening device, and as power units become enlarged it will be necessary to provide means for limiting the total amount of power that can be delivered to individual branches. This object can be accomplished by inserting reactances in these branches; such reactances can be so proportioned that they do not materially interfere with the normal operating conditions, and, at the same time, they can so limit the total power delivered that it is kept within the safe range of the circuit-opening devices. Up to the present time, such reactances have not been much used.

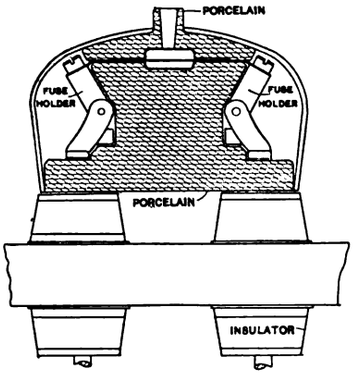



FIG. 1.—AN EXPULSION TYPE FUSE.

I have prepared sketches of a few circuit-opening devices that have resulted from recent investigations and experiments, and will briefly describe their design.

Fig. 1 shows a fuse block in which the fuse is in a state of tension between two hinged terminals; these terminals are pulled apart by springs and receive current through flexible connections. The fuse is punched out of sheet metal, the narrowest portion being at the middle. It is placed between two blocks of porcelain, a small amount of clearance being provided where the fuse passes through, so that its ends can be freely withdrawn by the movable terminals after the narrow part of the fuse has become ruptured. Around the narrow part of the fuse the porcelain blocks are recessed so as to provide an air chamber; this chamber is vented by a hole in the upper block. The whole device is firmly clamped together, so that the only opening to the outer air is through this one vent-hole. The fuse, being under tension, does not quite reach the melting point before the break occurs. It loses its tensile strength at a low red heat and pulls apart. It is quickly withdrawn by the springs from the air chamber in which it has been broken. A very small amount of the metal is volatilized and its gas is blown out of the vent-hole. For the purpose of preventing any deposit of metal fumes on the porcelain surfaces, these surfaces are lined with muslin that has been treated with shellac or varnish and pressed into the desired shape. This lining covers the interior of the chamber in which the fuse is broken and the porcelain surfaces between which the fuse is drawn. These linings are supplied with the new fuses and are renewed if any appreciable amount of burning has occurred.

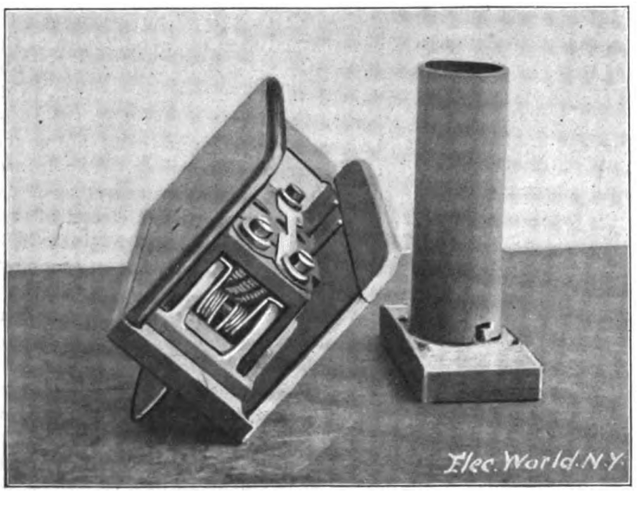



FIG. 2.—VIEW OF AN EXPULSION TYPE FUSE.

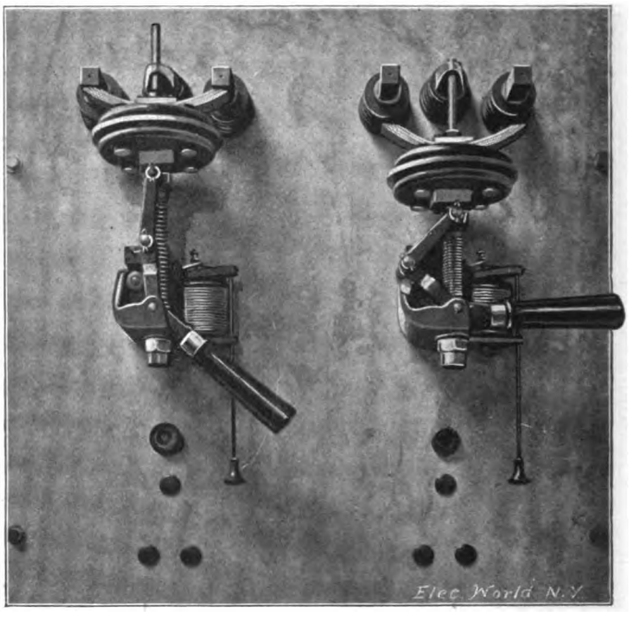



FIG. 3.—A SHUNTED FUSE CIRCUIT BREAKER.

With a fuse of this type, occupying a space of 6 in. by 3 in. on a switchboard, I have repeatedly broken 300 amperes at 13,000 volts without the slightest injury to the device.

Another switch or circuit breaker for the same purpose utilizes oil to extinguish the arc between the contacts. In this case the terminals are at the lower

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end and are situated inside of vessels into which the fiber tubes project for a short distance. These vessels are partly filled with oil, the break occurring below its surface. In the switches of this type which we have designed the rods have been withdrawn from the tubes by a pneumatic cyclinder. The presence of the oil materially increases the breaking power of the switch and reduces the violence of the explosive effect when the circuit is opened.

Fig. 3 shows a shunt fuse device that has been used in connection with circuit-breakers at Niagara Falls and elsewhere. The object of the design is to produce a fuse that can be placed in shunt with the circuit-breaker, to open the circuit after the main contacts are broken. It is, of course, desirable so to design such fuses that they can be very easily replaced. The fuse is placed in a slot in a long, wooden rod; this wooden rod is covered by a paper tube, and part of the wood is cut away at three points, so as to form air chambers inside of the paper tube. The rod is inserted in a long, wooden tube provided with vents that come opposite to these air chambers when the fuse is in place. The fuse is a small copper wire, and is attached to ferrules on the rod which make contact with springs at both ends of the tube. When the current is diverted into the fuse, which immediately volatilizes, the pressure in the chambers bursts the paper opposite the vents and the gas escapes through chimneys provided above the vents. The paper covering of the rod prevents the hot gas from getting into the interior of the tube; consequently the device can be used over and over again without any deterioration. These fuses have worked perfectly in parallel with circuit-breakers under the most difficult conditions that we have yet been able to produce.

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The session of Thursday forenoon opened with a paper presented by Mr. H. M. Atkinson on

### ALTERNATING-CURRENT GENERATION AND DISTRIBUTION—CHANGES CONTEMPLATED IN ATLANTA.

We feel that we have a company in Atlanta that is a success. It has paid the people well who invested their money in it, and is doing so to-day. It is producing current at what we consider a low cost per kilowatt. With a successful record in the past, with everything running smoothly and satisfactorily, and with a bright outlook for a constantly increasing business, it is a hard thing to face radical and expensive changes, but the growth of our business forces us to act. We concluded early in the spring that we must have increased capacity to carry our load during the coming fall and winter. Two alternatives faced us: First, should we go on and add in conformity to our present equipment, or, second, should we depart radically from our past methods and, as it were, take a fresh start?

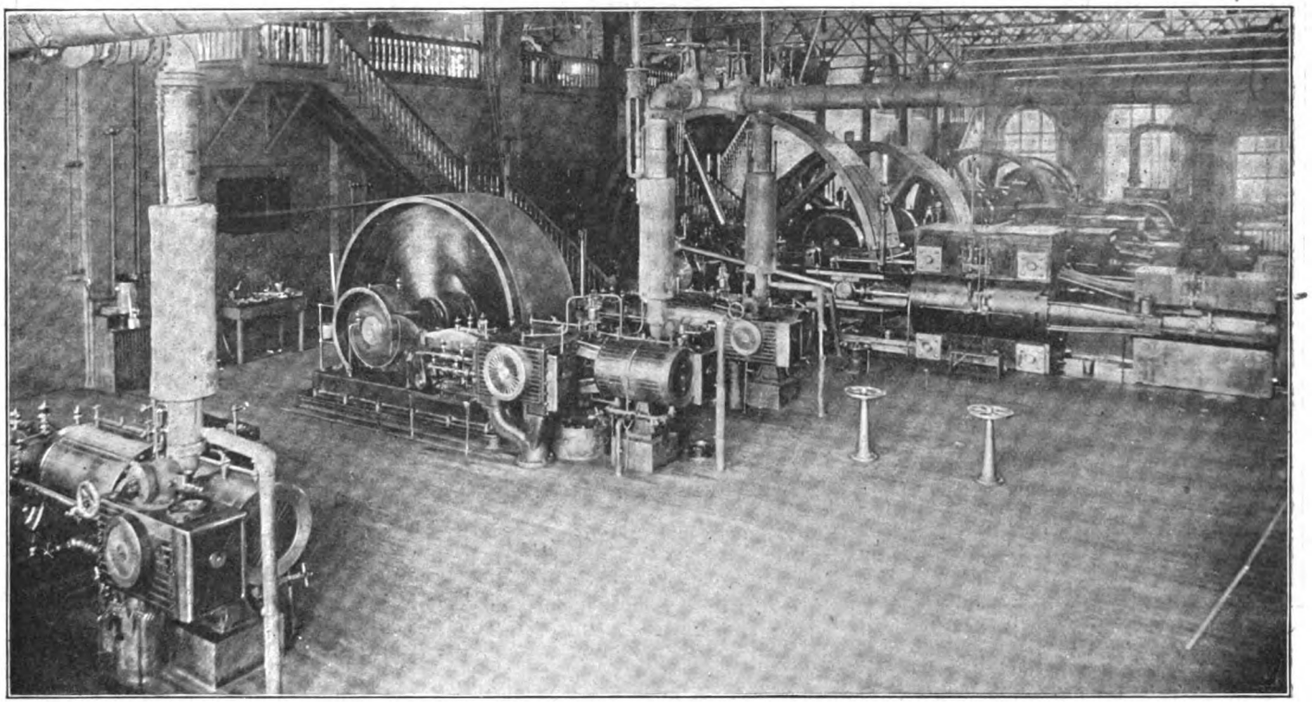
The station has seven large engines in the engine room, all of different sizes and all differing in many particulars, but all good engines of their kind. Most of these engines belt to counter shafting and the counter shafting belts up to thirty-seven small units. Three kinds, or perhaps more correctly four kinds, of current are generated and distributed.

Our dynamo room contains a number of small 1,000-volt alternators, three different kinds of direct-current series arc machines and four different kinds of power machines. The small alternators work at 125 cycles while the large direct-belted unit works at 133 cycles.

The different kinds of current that our station is generating to-day are as follows: 133-cycle, 1,000-volt, single-phase, 125-cycle, 1,000-volt, 500-volt direct current, 500-volt direct-current railway, 10-ampere direct-current arc, from three kinds of machines; and to do this work we are operating thirty-seven dynamos and generators and seven exciters. This complicated and varied equipment is the natural result of the state of evolution that we have been going through, and I do not think that anybody can be rightly blamed for it.

Our general plan for the future is to send the electrical output to the distributing wires—whether for direct-current, series alternating-current arcs, direct-current series arcs or any other kind of business—from large generating units of similar design and type working in multiple.

Taking up the question of periodicity, our field presents the possibility of a very large motor business. The lighting will fix the low limit of cycles, consequently we must use as low a cycle as possible for the best accommodation of our power business, but still high enough to handle our lighting service satisfactorily. Forty or forty-two cycles have been found to give unsatisfactory results on some classes of lighting, so that it is possibly wise to put fifty cycles as the lowest limit for lighting purposes. The manufacturers have chosen sixty as their standard. All the leading manufacturers build machinery and apparatus of this cycle, which is an added reason for selecting sixty. Special



THE ENGINE ROOM OF THE CENTRAL STATION OF THE GEORGIA ELECTRIC LIGHT COMPANY, ATLANTA, GEORGIA.

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machinery is objectionable on many accounts, and we should avoid it not only in our own interests but in the general interest of our business. Another point in favor of sixty is that it is the standard for arc lighting, consequently our decision is for sixty cycles.

Next comes the question of primary voltage. Our lighting center is not over one mile from our station, and will probably not be over a mile and one-half to our most distant motor, so that in either case the copper losses can be kept inappreciable without undue expense. Should work in time develop at greater distances, step-up transformers could be used in case the line losses shall figure greater than the transformer losses; therefore, we shall use 2,300 volts for the primary voltage.

Next we come to the phase of generator. This has been, perhaps, the hardest question to solve satisfactorily. There is not, perhaps, so much in the question of whether three-phase or two-phase is best, as a good many people make out. Be that as it may, we early reached the decision that single-phase, alternating current is the best system for our incandescent distribution, and that, whether two phases or three phases were employed in generating, only one phase finds its way to individual customers. Therefore, in order to get this single-phase, we must determine how we can get our primary current from our generator, still having in mind our decision to use a generator well adapted for a power business. A generator well adapted for power business must be two or more phase. Two-phase is simple, if all phases are distributed on streets for lighting only, but the majority of central-station men have a preference for the still greater simplicity of one phase under such conditions. Three-phase requires less copper for motor work. It is our intention to run lights from each phase in different sections of the city, and we must be prepared to run motors of any power from all three phases.

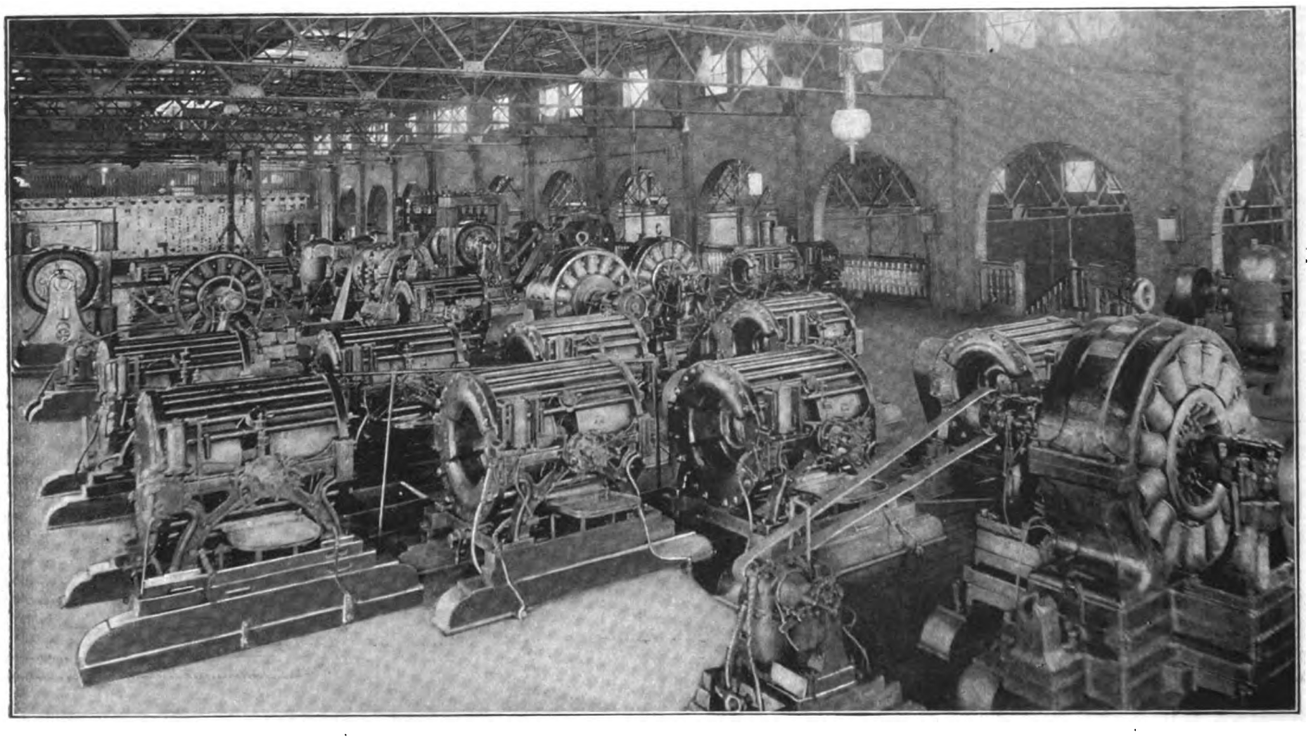
It seems best to us to employ the form of generator that is most economical in copper cost for motor distribution. This feature of our business has influenced us largely in our decision for three-phase generators. We intend to take the three primaries to our larger motors and to use induction regulators on each of two phases, regulating the third phase by the machine voltage and keeping this just right for the three-wire network that carries three-quarters of our incandescent-lighting load. A good point about this three-phase generator that we have selected is that it will, if we only load one phase, i. e., run it as a single-phaser, take 70 per cent. of its three-phase load on one phase at practically its three-phase efficiency. This is a case that probably never will occur in practice, but it is a point in favor of the generator.

Our street lighting at present consists of the equivalent of 870 9.6-ampere series arc street lights and 70 commercials. Our plan contemplates, of course, ultimately taking these lights off of three-phase generating units, either on the motor plan, using induction of synchronous motors and large arc machines, or "tubs" and series alternating arcs. For certain reasons we are undecided as to which of these plans we should use.

The unit we have just bought, of 400 kw. capacity, will take care of our day incandescent as well as any new power work, and would, with a larger unit of 1000 kw., which we contemplate buying, take care of the peak of our incandescent load as it stands at present. These two units, one of 400 kw. and the other of 1,000 kw., will be overloaded to the limit of safety as the business grows, and when we have gone as far as possible with them we shall add another large and duplicate set, running all three in multiple and dividing the load between them. We shall have a leeway of a good many months in which to decide whether to run our arcs from station motors or "tubs," and we think that these additional months will be of great importance to us in reaching a decision.

We shall use as large transformers as possible on each phase, keeping the number down to a minimum, and they will feed into our three-wire network. These transformers will be placed under ground in the central section of the city, and as the load drops off we intend that our trouble man, who is constantly on duty at our office within this district night and day, shall cut off unnecessary transformers. This will save the loss on such transformers as we are able to cut out for a large part of the twenty-four hours. We would not, perhaps, recommend this in all cases, but under our conditions it is practicable and will effect economy.

We hope to use single-phase motors of 1 h.p. and less. For heavy power work we intend to use induction motors running from motor transformers with the third wire brought across.



THE DYNAMO ROOM OF THE GEORGIA ELECTRIC LIGHT COMPANY.

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Another paper of interest was that presented by Mr. Geo. W. Hubley on the following subject:

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### TRANSFORMERS, IRON LOSS, ITS INCREASE, THE REMEDY.

It has been found in practice that transformers having initially low iron losses (within limits of specifications), after being placed in service, would show most decided increase. In most cases over one hundred per cent. increase, and in exceptional cases as high as three hundred to four hundred per cent. increase, within very short periods of service under normal conditions.

In fact the "fatigue" feature or large increase of iron losses in many transformers made their further use commercially prohibitive.

To illustrate the conditions of the question, the writer gives the following records of a few tests on various sizes of transformers, showing the increase of iron losses during periods of service:

| Capacity. | Initial Test. | | Second Test. | | P. Ct. Inc. | Third Test. | | P. Ct. Inc. | Total P. Ct. Inc. |
|---|---|---|---|---|---|---|---|---|---|
| | Watts. | P. Ct. | Watts. | P. Ct. | | Watts. | P. Ct. | | |
| 500 | 36 | 7.2 | 65 | 13 | 80.6 | 75 | 15 | 15.4 | 108.4 |
| 1,000 | 58 | 5 8 | 75 | 7.5 | 29 3 | 100 | 10 | 33⅓ | 72.4 |
| 1,500 | 60 | 4 | 97 | 6.5 | 61¾ | 120 | 8 | 23 7 | 100 |
| 2,000 | 75 | 3¾ | 125 | 6.1 | 66⅔ | 145 | 7¼ | 26 | 93 4 |
| 3.000 | 80 | 2⅔ | 133 | 4 4 | 66¼ | 150 | 5 | 12.8 | 87½ |
| 4,000 | 109 | 2 7 | 175 | 5¼ | 60 6 | 185 | 4.6 | 5 7 | 69 7 |
| 5,000 | 120 | 2.4 | 140 | 2 8 | 16⅔ | 145 | 2.5 | 3.6 | 24 8 |
| 7,500 | 145 | 1.9 | 167 | 2 2 | 15 1 | 190 | 2.6 | 13.8 | 31 |
| 10,000 | 190 | 1.9 | 250 | 2.5 | 31 6 | ..... | ..... | ..... | 31 6 |
| 12,500 | 218 | 1 7 | 238 | 1 9 | 9.1 | 315 | 2.5 | 32.4 | 44.5 |
| 25,000 | 523 | 1.3 | 530 | 2.1 | 64.1 | ..... | ..... | .... .... | 64 1 |

The above tests represent transformers of various types of manufacture during years of 1894, 1895 and 1896, and cover periods of service from 1894 to 1899. The actual service between tests vary from periods of six months to two years, but in most cases are tests made each consecutive year.

The following specification limits were adopted January 1, 1899, and all transformers must pass under initial conditions within specified limits, or be rejected:

| Capacity | Iron Loss. | | Regula'n Per Cent. | Capacity | Iron Loss. | | Regula'n Per Cent. | Capacity | Iron Loss. | | Regula'n Per Cent. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Watts. | P. Ct. | | | Watts. | P. Ct. | | | Watts. | P. Ct. | |
| 500 | 35. | 7 00 | 3.00 | 3 750 | 90. | 2 40 | 2.50 | 15,000 | 210. | 1 40 | 2.00 |
| 600 | 36 | 6 00 | 3.00 | 4,000 | 90. | 2 25 | 2 50 | 18,750 | 225. | 1 20 | 2 00 |
| 1,000 | 45. | 4 50 | 3 00 | 5.000 | 110. | 2 20 | 2 25 | 20 000 | 240. | 1.20 | 2 00 |
| 1,250 | 45. | 3 60 | 3. 0 | 6,000 | 120. | 2 00 | 2 25 | 25,000 | 275 | 1 10 | 2.00 |
| 1.500 | 51. | 3 40 | 3 00 | 6,250 | 125. | 2.00 | 2 00 | 30,000 | 300. | 1 00 | 2 00 |
| 2 000 | 60. | 3 00 | 3.00 | 7,500 | 150. | 2 00 | 2.00 | 37 500 | 375 | 1 00 | 2.00 |
| 2,500 | 65 | 2 60 | 2 50 | 10,000 | 175. | 1.75 | 2 00 | 5 ,000 | 500. | 1.00 | 2.00 |
| 3,0 0 | 75. | 2.50 | 2 50 | 12 500 | 200, | 1 60 | 2.00 | ..... | ..... | ..... | ..... ..... |

Insulation test to be made by a series of make and break contacts, and one prolonged contact, as follows:

1. Between primary and secondary coils, 6000 volts a. c.

2. Between primary coil and core, 6000 volts a. c.

3. Between secondary coil and core, 1000 volts a. c.

Temperature test measured by thermometers placed in mercury cups in core of transformers. Increase above surrounding atmosphere on full load test of eight hours' duration must not exceed sixty degrees centigrade.

Fatigue.—Iron loss must not exceed ten per cent. increase above limits, as specified, within period of two years' service.

Overload.—Transformers must be guaranteed to stand overload of twenty-five per cent. above rated capacity, for duration of two hours, with temperature increase not to exceed sixty degrees centigrade above surrounding atmosphere.

General Guarantee.—Transformers must be guaranteed for two years' service against burn out from any cause (including lightning); providing same are under normal conditions of service.

Remarks.—The above specifications do not contemplate the use of oil in transformers.

It is probably unnecessary to state what the iron losses and their increase mean to the average central station, except to call attention to the fact that existing iron losses in transformers approximate from fifty to seventy per cent. of output of the average alternating station.

The question naturally arises, "What is to be done with transformers having abnormal "iron loss?"

The writer began some experiments in line of treatment of iron of old transformers, and after some time obtained most successful and gratifying results in this direction. However, no claims can be made at present writing of the permanency or resultant action that may occur by the methods adopted, as only time test will determine this point; but it is reasonable to expect the changes made in the character of the iron in transformers, so treated will prove itself more nearly constant and permanent than it was initially.

The method of treatment adopted is one of annealing the iron of transformers which show abnormal loss. The results have proven most gratifying, in all cases reducing the losses to their initial (or even better) records, and in no manner affecting other requisite qualifications of the transformer.

The work can be done readily and at an admissable low cost per unit, to make the work commercially within bounds, and a far better paying investment than any other plan that has been suggested or followed with the same object in view. In other words, it restores the transformer system, whether transformers are new or old type, to their original, or even better condition, as far as iron losses are concerned.

The "annealing treatment," as practiced, can be accomplished at so low a cost per kw. that it insures its success.

The following data of detail costs per kw. capacity have been computed from records of actual costs during period of experimental work.

| | Preparation. | Annealing. | Assembling. | Testing. | Total cost. |
|---|---|---|---|---|---|
| Average cost per K. W.... ..... | .092 | .106 | .618 | .084 | .90 |

However, the above costs cannot be taken as representative as they only represent the result of experimental work on transformers of various manufacture, type and capacity, and naturally these costs as given are considerably higher than will be found in practice.

It can be liberally approximated that complete costs of "annealing treatment" will vary between twenty-two cents per kw. on 25 kw. size to $2.20 per kw. on ½ kw. size of transformer.

### GENERAL S. T. CARNES.

The president of the association elected for the coming year is General S. T. Carnes, of Memphis, Tenn. General Carnes has been for several years president and general manager of the Memphis Light and Power Company. He is one of the most prominent citizens of Memphis, having spent his whole life in that city. His title was gained through his position of Brigadier-General in the State of Tennessee.

## Among Our Foreign Contemporaries

**Novel System of Electric Bells.**—An interesting improvement, though not entirely new, is described in "L'Electricien." In this the bells, of which there are supposed to be a number in the installation, are made without the usual interrupter of the current and consists merely of the magnet, the armature, the clapper and the bell. The interruptions of the current are produced by a single interrupter, which is placed in the main circuit near the battery; this interrupts the current for any one or more of the bells. The advantages are evident, as the bells became cheaper and more easily maintained, as they require no adjustment and need not necessarily be made dust-proof. The interrupter is a small, simple affair enclosed in a box and placed where it is easily accessible.

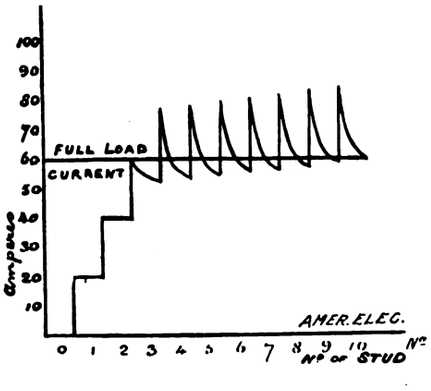
**Energy Required for the Production of Calcium Carbide.**—While the important data for finding the amount of production or the cost of calcium carbide are those obtained in practice, yet the quantity of energy required theoretically is also of some interest. Mr. Gin, in "L'Eclairage Electrique," shows how this is calculated

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and he finds that the quantity of energy necessary for producing a ton of the carbide is about 4260 kw. hours, which corresponds to a production of 5.63 kg., that is, 12.39 pounds of carbide per kilowatt per day. In a large plant in Austria it was found that the power required was 5.2 kg., which, if the theoretical figures are correct, corresponds to the very high efficiency of 92%. The amount of energy referred to is, of course, that generated in the furnace itself and not that of the original machinery.

**Regenerative Primary Battery.**—An improved form of the cell consisting of zinc and peroxide of lead, which gives as much as 2.5 volts, is described in the "Elektrotechnische Zeitschrift"; it is the invention of Messrs. Exner and Paulsen. In general this form of primary battery has been well known and has been a favorite subject for improvements owing to the very high voltage which it gives, thus utilizing the zinc to better advantage. There are, however, a number of objections, and it is these that the present inventors tried to overcome. The liquid, being sulphuric acid, is apt to attack the zinc on open circuit, and the peroxide of lead is also gradually attacked; acetic acid has been used, but it does not seem to be a success. In the present improvement a very weak solution of sulphuric acid is used, to which saccharic acid is added, besides some sulphate of mercury dissolved in ether. A weak gelatine solution is also added, which is claimed to protect the zinc on open circuit. This electrolyte, it is claimed, will not attack the peroxide of lead and the mercury salt, together with the gelatine, are said to protect the zinc. The battery is merely an improved form of what is known as the zinc-lead peroxide accumulator. It is regenerated by charging it with a current in the reverse direction, just like any other secondary battery.

**Calculating the Resistance for a Motor Starting Switch.**—A very simple method of calculating the various steps for starting resistance of a motor, if one is provided with a slide rule, is described by Mr. Hunt in the London Electrical Engineer. The calculation is, of course, divided into two parts, one the determination of the resistances in ohms necessary to produce a regular series of steps, and the other is to calculate the diameter and length of wire required to carry the respective currents without too much overheating. The conditions to be complied with are generally of the form that the current passing through the switch on the first knob must not exceed a certain amount and that when any succeeding sections are cut out the current must not increase to more than that amount; another condition is that the number of contacts must not be less than a given amount; from the first condition such a minimum is naturally involved. Up to the point at which the motor starts to run the calculation of the required resistance is merely an application of Ohm's law, that is, it is the quotient of the line voltage divided by the current which is allowed to pass. Unless there is a specification to the contrary, it is advisable to assume that the motor has to start with a full load, and in that case it will not start unless it receives the full load current. When the armature begins to move it generates a counter e. m. f. which tends to cut down the current, and as soon as the switch arm is moved to the next point there is a sudden rise again. The whole process is shown in the accompanying diagram in which the horizontal distances




represent the various contact points on the switch and the vertical distances the currents. The various resistances should evidently be so proportioned that the rise and fall of current shall take place over the same range for each contact point, assuming that the switch remains long enough in each position for the armature to run its full speed for that resistance. To fulfill this condition the resistance must be in a descending geometrical progression, a statement which he proves, on the assumption that the current is to fluctuate between a fixed maximum and minimum. The value of the resistances from the point where the motor starts is known, and the resistance in circuit for the last contact point is that of the armature only. All that is required, therefore, is to insert a number of geometrical means between these two extremes, and this is done most simply with the aid of the slide rule. To do this, find the two extreme values on the scale of a slide rule and then on a strip of paper divide the length between them into a number of equal parts, one more than the required number of means, and then read off the values at each division, which will give the required resistances. After having found these resistances it is necessary to calculate the length and diameter of the wire, which is done by means of the well known formula that for a given rise of temperature the current is equal to a constant multiplied by the square root of the cube of the diameter; the constant measured depending on the material and on the temperature, as also on the perfection of the ventilation, etc. It is, therefore, not possible to give any more than approximate values for this factor, and those he gives are as follows: For German silver from 1000 to 1500, platinoid 800 to 1300, Eureka 700 to 1100, tinned iron about 1100 to 2000.

**A 250-Volt Incandescent Lamp Installation.**—The introduction of high voltage incandescent lamps appears to be making better progress abroad than in this country. There is a small town in Italy called Arenzano in which a central station was installed last year, using the three-wire direct-current system with lamps of as high a voltage as 250, which is the highest of which we have read. This makes 500 volts between the outers, as as this is the same as used on most trolley lines it enables the two systems to be combined to advantage, at least in so far as using the same generators is concerned. A brief reference to this interesting installation is published in L'Electricien, but, unfortunately, very little information is given. The reason for using such a high voltage seems to have been that a water-power situated from 1 to 1.5 miles distant is used directly without transformation, and at the same time without a great loss in the feeders, or an excessive cost of copper. The advantage of the direct instead of the alternating current which would ordinarily be used in such an installation, is that no transformers are required and that accumulators may be used to store the energy. This latter is a very important feature in cases in which the water-power is comparatively small, requiring that some of the power be stored during the hours when little current is being used. To store the energy in an alternating current plant would require a complicated station for transforming the currents and this, besides being expensive, requires attendance. So far the station has been very satisfactory and no objections have arisen to the use of such high voltage lamps. If they continue to be a success it will enable the direct current to be used in many cases in which the alternating current is now necessary on account of the heavy cost of the copper feeders.

**Radiography.**—An Italian investigator states that a metallic reflector immediately behind a photographic film is beneficial in taking X-ray pictures, provided films and not glass plates are used. Two other Italian writers, however, claim that the metallic backing is beneficial in all cases, although less so with glass plates, and it is more important the harder the tube and especially when tocus tubes are used; it tends to avoid the fogging and want of contrast. With soft tubes requiring long exposure, it is not so necessary.

**Alternate Current Arc.**—What is probably the most prolonged, careful and complete investigation of the alternating current arc was recently made by Messrs. Duddell and Marchant and is described in a long paper, which they read recently before the Institution of Electrical Engineers in England. Among the many facts which they point out and conclusions to

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which they arrive, the following may be of interest to those who are designing or using alternating arcs or are experimenting with them. Their investigations deal chiefly with the examination of the wave forms of the current, of the voltage of the arc, and the voltage of the dynamo. They found that at any instant the distribution of the voltage in the arc is similar to that in the direct current arcs. The efficiency of the alternating arc is effected by the amount of resistance in series with it. The effect of reducing the frequency of the alternating current is to greatly increase the actual time during which the current remains small in each period and also to increase the fraction of the period during which it is small. Accompanying this is a considerable increase in the maximum value of the current and a decrease of the frequency. The arc between solid carbons becomes very unstable below a frequency of 57; the arc between solid and cored carbons below 46, and between cored carbons at about 29, at which frequency the light was exceedingly unpleasant to the eye on account of the visible pulsations. The power factor was reduced by lowering the frequency. The light efficiency is increased by a reduction of the frequency, but there is a limit, owing to the instability of the arc at low frequencies. The quality of carbon used modifies the amount of the reactions of the arc on the form of the wave, but does not otherwise change the reaction itself. They also found that it is possible to considerably reduce the voltage necessary to maintain an arc of a given length and current, by treating the carbons with a potassium salt; they also think it is likely that the lower voltage and steady burning of arcs between cored carbons are largely due to the presence of a potassium salt in the core.

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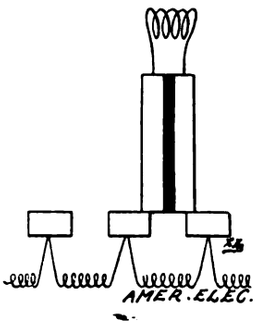
**High Efficiency Incandescent Lamp.**—Some time ago the startling news was published that Maxim, one of the pioneers in the invention of the incandescent lamp, had succeeded in improving the lamp so that there would be a saving of 25 per cent. in the number of watts required per candle. It now appears from London "Lightning" that not only has this efficiency been reached, but even exceeded, and that a factory for making these lamps at a rate of 6,000 a day, the largest factory of the kind in England, is in course of construction. The consumption of energy of these lamps is said to be only 2.8 to 3.0 watts per candle, as compared with 4 to 4.5 watts in the usual lamps. No further information is given at present, but more is promised soon.

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**Transformer Cores.**—It has been found by several English investigators that pressure on the laminated iron of the core of a transformer increases the hysteresis loss very considerably. A pressure of 2200 pounds per square inch, for instance, increased it about 53 per cent. Mr. Scott, in the London "Electrician," therefore points out that it is bad practice in building up transformers to tighten the bolts which hold the plates together, any more than it is absolutely necessary for good mechanical construction. The several makers of transformers have now adopted a construction in which the plates can expand and contract. He also considers that punching and hammering the plates is a very objectionable method, as it affects the iron losses; he strongly recommends changing the design so that the plates can be cut instead of being punched.

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**Improvement in Step-by-Step Resistances.**—In step-by-step resistances, such as are used for regulating field magnet currents for motor starting, switches, etc., it is often desirable to diminish the amount of resistance in each step so as to be able to adjust more accurately. A method for doing this without increasing the number of contact points was recently described in the "American Electrician," but since then another method differing slightly from it was shown in "L'Electricien" by Mr. Goichot. It consists simply in the use of one movable coil secured to the movable arm, and having its ends terminate in blocks or strips which come in contact with the knobs of the usual resistances. When its two ends are connected to two contact points of the resistance, as shown in the adjoining figure, it is evident that the additional coil will be in multiple with one of the regular coils; when moved slightly farther to the right or left the additional coil will not be in circuit. The arrangement thus enables all the other resistances to be obtained, besides one more step between each of the others, thus practically doubling the number of steps.




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**Automobiles in Germany.**—A large company in Germany is making the lower or working parts of various forms of automobiles on which different kinds of carriage bodies may be placed as desired. Their standard sizes are described and illustrated in a recent issue of the "Elektrotechnische Zeitschrift," and as the company seems to have made a thorough study of the problem, the conclusions that they have reached may be of some interest. For an omnibus the trucks have two motors and the hind wheels are used as drivers; the front wheels are knuckle jointed and ball bearings are used on all of the wheels. The different speeds are obtained by dividing the battery into two halves and connecting these variously in parallel or in series with the two motors which are also parallel or series. In braking, energy is restored to the battery, thus saving considerable wear on the brake blocks and tires. On the roof of the omnibus are movable contact bars such as are frequently used on German trolley lines, which enable the omnibus to be charged by simply passing under two trolley wires. There are 44 cells to the battery and one charge is supposed to run 12 miles, but it is recommended to recharge for 15 minutes at the end of about every five miles. The total weight of an omnibus for 18 passengers is 7700 pounds. Another form of truck is intended for delivery wagons, pleasure carriages for a number of passengers, for the mail, etc., or in general for a load of 1000 to 2000 pounds. This contains only one motor, the hind wheels being driven as before. The batteries are also connected in parallel or series for regulation of the speed; the capacity of the accumulator is enough for a trip of about 18 miles. It appears that the wheels of none of these are provided with rubber tires. A third form of truck is for the ordinary city carriage for three to four persons besides the driver; it has two motors and the controller enables it to be run at four speeds, but the battery is not divided into two parts. The maximum speed is 12 miles per hour, and the weight of the unloaded carriage is 2400 pounds. Some tests made with an omnibus weighing 5.1 tons showed a consumption of 80.5 watt hours per ton kilometer. In another, over a longer run, the consumption was 77.2 watt hours per ton kilometer.

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**Quick Method of Calculating the Weights of Conductors.**—An interesting method of rapid calculations and more especially comparisons between the costs of different materials for the line, such as copper, iron or aluminum, is described in "L'Industrie Electrique." The mass, that is, the weight, of a line of given length and resistance, is proportional to the product of the resistivity (that is, the specific resistance) and the density of the material, both of which are physical constants. This product for iron is 78, for copper 14.24, and for pure aluminum 7.54; the weight of metals for lines made of these materials will therefore be in the proportion of these figures. If, for instance, the cost per pound of aluminum is about double that of copper, then the cost of the line will be equal for these two materials, because 14.24 is about double 7.54; when the cost of aluminum becomes less than that, it will be the cheaper of the two metals. The actual weight of a line in kilograms is determined by the following formula, in which L is the length going and returning, in meters, R the total resistance in ohms, r the specific resistance in microhms per cb. cm. and D the density:

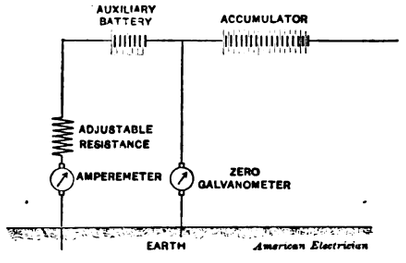
$$W = \frac{L^2 rD}{R \times 1000}$$

For commercial copper at 15°C the product of rD may be taken to be equal to

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16 and the value of R is readily determined from the allowable loss in the line.

**Measuring the Insulation Resistance of a Large Number of Accumulators in Series.** - If it may be assumed that a battery of a series of accumulators has only one fault in the insulation resistance between it and the earth, it is a simple matter to determine this, as it is only necessary to connect a voltmeter first between one pole of the battery and the earth and then between the other and the earth, and from the deflections and the resistance of the voltmeter, the insulation resistance may then be calculated. If, however, there are, as is generally the case, a large number of points of leakage, this method fails and it is for this case that Mr. Liebenow in the "Elektrotechnische Zeitschrift" describes a very simple method of measuring the total insulation resistance. The battery must first be disconnected from the circuits; an ampere meter is then connected between one pole and the earth and another measurement




made between the other pole and the earth; the insulation resistance is then equal to the voltage of the whole battery divided by the sum of the two currents which were measured, regardless of their signs. If greater accuracy is required, or if the insulation resistance is very high, he suggests using a higher resistance ampere meter and a small but well insulated auxiliary battery which is connected in series with the main one, so that the voltages are added to each other. The resistance is then calculated in the same way except that twice the voltage of the auxiliary battery is added to that of the main battery; and that from the resistance, that of the ampere meter must first be subtracted. It is necessary in this case that twice the voltage of the auxiliary battery is greater than the product of the resistance of the galvanometer by the sum of these two currents. If the resistance of this auxiliary battery cannot be neglected and is not known, or if that of the ampere meter is not known, he suggests the method shown in the adjoining illustration. A second galvanometer, which is a mere zero instrument like that used in the Wheatstone bridge, is connected as shown and an adjustable resistance is added in series with the ampere meter, it being adjusted in each case so that the deflection of the other galvanometer is brought down to zero. This test is repeated for both ends of the battery, and the insulation resistance is then as before equal to the voltage of the main battery only, divided by the sum of the two curents read in the ampere meter. This method is said to be quite accurate, but it is necessary that the voltage of the auxiliary battery is sufficiently great to bring the other galvanometer to zero; the voltage required will be less the greater the insulation resistance. To provide against injuring the instrument in case there is a dead ground in the battery, each of the battery poles should first be grounded through a fuse (each separately, of course), before the ampere meter is in circuit.

**Zinc Plating.**—It may not be as generally known as it ought to be that a coating of zinc on iron acts quite differenly than when the iron is plated with other metals, such as nickel, silver or copper. Unlike these other metals, zinc protects the iron electrically by virtue of the fact that in the presence of moisture a galvanic couple will be formed between the zinc and any exposed parts of the iron, which will cause hydrogen to be formed on the exposed iron, and this tends not only to keep rust from forming, but will also reduce any rust which may have been formed. To successfully plate iron with zinc is, therefore, much more important than to nickel plate it, but unfortunately, it is much more difficult. The following receipt from the "Zeitschrift fuer Elektrotechnik" may therefore be of interest: The bath should have a specific gravity of 1.135, or contain about half a pound of zinc sulphate per quart of water. Its current density should be about 0.1 to 0.2 amperes per square inch, and the solution should be kept stirred. The articles must be very carefully cleaned before plating, and the bath should be replenished with a mixture of zinc dust with about twice its weight of powdered coke, suspended in a bag.

**Accumulator.**—Great claims have been made for an accumulator manufactured in Italy in which the porosity of the oxides is produced by mixing with the oxide a material called ulmate of ulmine, which is made by boiling sugar in dilute sulphuric acid. This is an inert material which is gradually oxidized and dissolved, thus leaving the active material porous. It is used in the Pescetto accumulator, which is briefly described in the London "Electrical Review."

**Application of Electricity to the Manufacture of Glass.**—What seems to be a novel and practical application of the electrical furnace is described in our French contemporary, "L'Electricien." The process has been patented by Mr. Kroll, and is now used in an experimental plant in the city of Cologne, where the results are said to be very satisfactory. He uses an electric arc furnace with which the raw materials for the manufacture of glass are fused. The great advantage of the method is that a very small installation will replace the usual large furnaces and that it requires but 15 minutes to heat a charge which formerly required 30 hours of heating; in spite of the various transformations which the energy has to undergo, it is said that there is a very large saving in coal, which is doubtless due to the fact that the heat is so localized that the losses by radiation and conduction are very greatly reduced. It takes such a short time to fuse a charge that this furnace may be started or stopped at any time without great loss, instead of having to keep up the fires when no work is going on. The material produced is also said to be purer, as it is not contaminated with the ashes and particles of coal which get into the glass by the ordinary process.

**Temperature of the Bunsen Flame.**—Mr. Beikenbusch has measured the temperature of the non-luminous Bunsen flame by a new electric method and found it above 1820°C. His method was rather ingenious, as it eliminates errors existing in the methods heretofore used. He employed a thermo-couple, heating it by an electric current until it had the same temperature as that of the flame, so as to eliminate errors due to radiation and convection; the temperature of the thermo-couple for that same current is then measured in a vacuum. The general idea of making the two temperatures equal, and then measuring one of them by a more convenient method than measuring the original one directly, is a good one and may be applied in other cases to advantage.

**Efficiency of Man as a Machine.**—The human body when alive is, strictly speaking, a machine, converting the energy of the food into mechanical and other forces of energy, and the efficiency of this conversion is a matter of considerable interest. The problem of measuring it is necessarily an extremely complex one, as the value of the energy in the food is to be determined besides that in what leaves the body, including, for instance, the heat in the air of the breath, the vaporization of the moisture, etc. What seem to have been very painstaking researches of this difficult problem have recently been conducted by Dr. Marcet and Mr. Floris in a British Royal Society paper, a very brief acount of which is given in the London "Electrician." These seem to show that in general the efficiency of man as a human machine is a little less than 20%. This, as will be seen, is far superior to that of the steam engine together with its boiler, and also much higher than that of an ideal Carnot heat engine when it is working between the limits of temperature found in the human body. If man were simply a heat engine his vital organs would have to operate at temperatures like those in a gas engine in order to develop such a high efficiency. The mechanism by which this action takes place seems to be still obscure, the only thing known being that it is a sort of physico-chemical engine which differs from any form of mechanical engine which we know of.

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# NOTES.

**Mr. Charles F. Brush,** of Cleveland, O., has received from the American Academy of Arts and Sciences in Boston the award of the Rumford medal for the development of arc lighting.

**A Rheostat Museum.**—The Cutler-Hammer Manufacturing Company, Chicago, is making a collection of rheostats and already has a number of curious specimens. To make this collection more complete the company offers to replace 10 starting rheostats over five years old and under 10 h. p. with its latest type of apparatus.

**Railway Feeders of Aluminum.**—The North Western Elevated Railroad of Chicago has closed a contract for 150,000 lbs. of aluminum for use as feeders to its third-rail system. The conductors will be placed in a wooden box or trough covered by the board walk between the tracks, and will be supported on vitrified clay blocks placed 9 ft. apart.

**Electrical Supplies for Our New Possessions.**—The demand has arisen for a catalogue of electrical appliances and supplies printed in Spanish for use in the newly acquired territory of the United States. Any one issuing such a catalogue or contemplating the publication of one would confer a favor upon the readers of the American Electrician by notifying the editor of that fact.

**The Telephone in Japan.**—The Imperial Diet of Japan has voted to expend $12,800,000 within the next seven years for the improvement of the government telephone system, and a young electrical engineer, Rinja Nakayama, has been sent to the United States for the purpose of investigating the latest inventions and improvements along that line. Japanese electricians will do all the work.

**An Automobile Club.**—About fifty owners or prospective owners of automobiles met in New York City June 7th, and effected a temporary organization of the Automobile Club of America. The purpose of the organization is to advance the interest of automobile owners by providing quarters for the vehicles, establishing proper regulations for the use of automobiles in the city and country, and exerting every influence in favor of good roads.

**An Automobile Repair Wagon.**—The Consolidated Traction Company, Pittsburgh, Pa., is about to add to its equipment an automobile emergency wagon, built by the Pope Manufacturing Company. The new wagon will have a storage battery that will give it a mileage of not less than 15 miles at an average speed of 10 miles per hour on ordinary city streets where the average grade does not exceed 1 per cent., and where the maximum grade does not exceed 10 per cent.

**The Consolidation of Many Lighting and Traction Companies in and Around Pennsylvania.**—The United Power & Transportation Company, although less than three months old, has acquired by purchase no less than fifteen companies all in operation furnishing electric light or power or operating street railways, having a total mileage of 250 miles, all in or near Lebanon, Reading or Philadelphia, Pa., Wilmington, Delaware, or Trenton, N. J. The authorized capital stock of the company is $12,500,000, of which sum 10 per cent. has been paid in.

**A Weekly Street Railway Paper.**—The first issue of the weekly news edition of the "Street Railway Journal" is that dated June 17th, 1899. The new publication will be devoted to news items which can thus be given more promptly and more fully than they can be in the monthly publication of the same name. The Weekly Bulletin of Advance Information, hitherto issued to advertisers and manufacturers, has been merged into the new weekly edition and the latter will be sent regularly to all American subscribers and advertisers of the monthly publication without extra charge.

**The New Structure of the Chicago Telephone Company.**—The addition to the building which the main exchange of the Chicago Telephone Company now occupies will more than double the size of the structure. The present building is 7 stories in height and the new one will be carried up to a height of 8 stories, the upper story being carried over the old building. This story, 80x90 ft. in dimension, will be used for the main operating room. In addition to its 12 exchanges in Chicago, the company now operates telephones in about 140 towns in the district immediately surrounding the city.

**A Name for the Electric Vehicle.**—The "Electrical Review" has announced the winning name in its prize contest for a name for electrically driven automobiles. The winning name is "electromobile" and was suggested by Mr. E. E. Ries. A few of the 400 names sent in are as follows:

| | |
|---|---|
| Accelawatt, | Autovolt, |
| Equine-nit, | Elecar, |
| Bacrotom, | Pacolet, |
| Automo, | Franklin, |
| Aut, | Automote, |
| Faraday, | Chevaless, |
| Autopropelectric, | Moby, |
| Electragon, | Plantemobile, |
| Trolley-Ho. | Electrola, |
| Moto, | Antihorse, |
| Locomobile, | Voltcar, |
| Telecar, | Quatrecycle, |
| Electrapel, | Odomotor, |
| Autogo, | Autema. |

**More Niagara Power for Buffalo Street Cars.**—It is reported that the Buffalo Street Railway Company will spend $1,000,000 on improvements this year. Of this $350,000 will be spent for electrical machinery for electrical transformers, converters, etc., for five new transforming stations in which the high tension polyphase Niagara power will be transformed to 550 volts direct current. The company now is taking 2,000 h. p. from Niagara, the balance being generated at the Niagara street steam plant. The new stations will do away entirely with the need of steam generation and will reduce greatly the copper losses of distribution.

**The Advance of the Nernst Lamp in Germany.**—From a lecture given by Dr. Nernst in Berlin it appears that Nernst lamps are now being made by the Allgemeine Elektricitats Gesellschaft in 25, 50 and 100 c. p. sizes with a life of about 300 hours and an efficiency of 1½ to 1¾ watts per candle power. Experiments are also being made with lamps of higher candle power. The wholesale manufacture of 110 and 220-volt lamps will be commenced as soon as the new works, which are being erected by the company for that purpose, are completed. The German patent office has dismissed all petitions against the validity of the Nernst lamp patents.

**The Use of Electric Traction in the Baltimore & Ohio Tunnel.**—The famous equipment of heavy electric locomotives for tunnel service on the line of the Baltimore & Ohio Railroad through the city of Baltimore, Md., is not used to nearly the extent that was originally anticipated. The delay caused by coupling and uncoupling the electric locomotives is so serious that practically all the passenger trains and about 25 per cent. of the freight trains are pulled through the tunnel by the steam locomotives, the steam and gases from which are not as serious as was anticipated. The result is that the generating station has considerable surplus power, which is sold to the surface railways.

**Street Railway Consolidation in Chicago.**—On June 2d the stockholders of the North Chicago and the West Chicago Street Railway Company authorized the lease of their properties to the New Chicago Union Traction Company; the latter is also considering the leasing of the Consolidated Traction Company, which operates the outlying surface feeder lines of the North and West sides. The elevated roads will probably also be taken over later. The new company has been incorporated with an authorized capital stock of $32,000,000, of which $12,000,000 is preferred and has already been subscribed. There remain outside of this consolidation the Chicago City, the South Chicago, the Calumet and the Englewood companies.

**Electric Cab Service for the New York Central Railroad.**—George H. Daniels, general passenger agent of the New York Central & Hudson River Railroad, has determined to establish an electric cab and carriage service at the Grand Central Station in New York City. A charging station and a general repair shop for the electric vehicles will be built in the station. The cabs are to be owned and operated by the railroad company. One hundred will probably be installed as soon as the station is completed. It is said that the railroad company has found it impossible to maintain a first class horse cab service at the prevailing rates of fare.

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**The National Electrical Code and Supplement.**—The Electrical Bureau of the National Board of Fire Underwriters has issued an edition of 1899 of the rules and requirements of the National Board for the installation of wiring and apparatus for electric light, heat and power, as recommended by the Underwriters' National Electric Association. The Bureau has also issued a supplement to the code, containing a list of electrical fittings that have been examined and approved by the Underwriters' National Electric Association for use under the rules and recommendations of the code. Copies of these may be obtained from Mr. Wm. H. Merrill, Jr., Electrician of the Bureau, 67 E. 21st Street, Chicago, Ill.

**The Survey for the German-American Cable.**—The preliminary surveying work over the proposed course of the cable between Germany and the United States via the Azores was practically completed June 10th, when the British cable ship "Britannia" arrived in New York harbor after having taken soundings between Fayal and Sandy Hook. The proposed cable will start at Emden, touch at Punta Delgada in the Azores, and probably end at Coney Island. By way of the Azores it will give an alternate route to Southern Europe through the Portuguese cable now operating. Its cost will be in the neighborhood of $5,000,000. The length between the Azores and New York will be about 2300 miles.

**Electric Vehicle Companies for Every State and Territory.**—The plans of the electric vehicle syndicate are gradually unfolding. Recently an important step was taken in the organization of seventeen companies under New Jersey laws, sixteen of them with a capital of $100,000 each, and one with a capital of $6,000,000. The latter company is to operate in Washington, D. C., while the others are to be distributed in Tennessee, Georgia, Ohio, Kentucky, New Jersey, Louisiana, Delaware, California, Michigan, Minnesota, Iowa, Maryland, Wisconsin, Indiana, Missouri and Virginia. It is said that the capital stock of these sixteen companies will soon be greatly increased and that similar companies will be organized in every State and Territory of the Union.

**A Notable Meeting of English Engineers.**—The second biennial engineering conference of the Institution of Civil Engineers was held in London, June 7th, 8th and 9th. The proceedings were inaugurated by the address of the President, now Sir W. H. Preece, Knight Commander of the Bath, who was recently knighted on the occasion of the Queen's eightieth birthday, in honor of his long and valuable services as the chief engineer of the British Post Office, from which position he has recently retired. Several valuable papers were presented before the electrical section of the conference. Many excursions were arranged for the members attending the conference and the headquarters of the Institution were filled with the usual large number of exhibits.

**A Merger Company in the Electric Railway Field.**—Closely associated with, and, in fact, a part of the combination of interests commonly known as the Whitney, Widener, Elkins syndicate is the American Railways Company, formed some months ago, the purpose of which is to purchase and operate electric railways throughout the country. During the last month the company has purchased the properties of the Consolidated Traction Company and of the Pittsburgh United Traction Company, both of Pittsburgh, Pa., thus bringing these companies into close communion of ownership with the street railway systems of New York, Chicago and other cities, owned by the members of the syndicate. The American Railways Company is also alleged to have purchased the railway and lighting systems of Springfield, Ohio, as well as other smaller properties of the same kind in New Jersey. Rumors come from other cities, notably Baltimore, of pending transactions of the same nature.

**The Largest Incandescent Lamp Ever Made.**—It would seem at first sight ridiculous to construct incandescent lamps of a candle power comparable with that of



A 5000 C. P. INCANDESCENT LAMP.

arc lights, owing to the superior economy of the latter, but for one particular purpose the incandescent lamp is far preferable. That purpose is light house illumination, in which the superiority of the incandescent is its greater fog penetration, the yellower rays of the glowing filament being dampened out and absorbed to a much less extent than the rays of an arc light. The Bryan-Marsh Company has on this account been experimenting on large lamps, the largest of which is one nominally of 5000 candle power, which was exhibited at the Electrical Show, and the magnitude of which can be judged from the accompanying reproduction of a photograph which is reprinted from the "Imperial Lamp Gazette." The lamp is of the standard double-filament type like the smaller Imperial lamps, the two filaments being in parallel with each other and each taking the full 236 volts. The economy was about 3 watts per candle, the total consumption of power being, therefore, some 15 kilowatts, requiring a current strength of over 60 amperes. The lamp was exhibited but three nights when it burnt out, owing probably to the intense heat to which the glass of the neck of the bulb was subjected. Owing to the fear that the filament would droop, the lamp hung in a position the reverse of that shown in the illustration, and the heat was very intense at the base, probably softening the glass, which then collapsed due to atmospheric pressure. A larger bulb in an upright position would eliminate this difficulty. The cost of construction and erection of this single lamp was over $1000.

**The Coming Electrical Show in Chicago.**—With the vigorous enthusiasm characteristic of Chicago, the contemplated expansion of the exhibit features of the coming street railway convention is receiving a hearty support which promises to make it a notable electrical exhibition. As mentioned in the last issue of the American Electrician, the National Exposition of Electrical Arts Company has been incorporated to handle the show, and the active way in which the company is pushing its work is already apparent. The exposition will be held at the Tattersalls Building on 16th and State Streets from September 25th to October 9th. The location is a convenient one and the building is admirably suited for the purpose, its floor space being 150x280 ft. Work has been already undertaken for the preparation and decoration of the building for the occasion. The date was selected partly on account of the large number of people who will visit Chicago for the purpose of seeing the Fall festivities as well as the government celebration of the laying of the cornerstone of the new Post Office. A special effort will be made to obtain exhibits of automobiles and an elevated track 300 ft. long will be provided for exhibiting the same in operation. The building will be illuminated with some 5000 incandescent lamps for the evening sessions. The electrical operating companies in Chicago, notably the Chicago Edison Company and Chicago Telephone Company, have exhibited their usual public spirited interest in the affair and will take an active part in assuring its success.

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**The Consolidation of Electrical Interests in Washington.** — The two electric light companies and most of the street railway companies in the District of Columbia have been absorbed by the purchase of a controlling interest in their capital stock by the Washington Traction & Electric Company. The street railway companies are as follows:

| | Miles of track. |
|---|---|
| Metropolitan Railroad Company (electric conduit) | 22 |
| Columbia Railway Company (cable) | 6 |
| Anacostia & Potomac River Railway Company (horse) | 15 |
| Georgetown & Tennallytown Railroad Company (electric) | 10 |
| Brightwood Railway Company (electric) | 11 |
| Washington, Woodside & Forest Glen Railroad Company | |
| Washington & Great Falls Electric Railway Company (electric) | 10 |
| Washington & Rockville Railway Company | |

The companies operating, but not in this consolidation, are the following:

| | |
|---|---|
| Capital Traction Company (electric conduit) | 22 |
| Washington, Alexandria & Mt. Vernon Railway Company (electric) | 26 |
| Washington, Arlington & Falls Church Railway Company (electric) | 10 |
| Washington & Glen Echo Railroad Company (electric) | 12 |

The consolidated company has opened subscription books for $12,000,000 of its authorized issue of $20,000,000 of 4½ per cent. bonds. (The authorized stock is $12,000,000.) The report of President H. H. Vreeland and Chief Engineer F. S. Pearson of the Metropolitan Street Railway Company of New York City estimates the combined revenue from the lighting and railway properties at about $2,400,000, and within three years at least $3,000,000 per annum. In the official prospectus the operating expenses are estimated at $1,150,000, leaving with the above mentioned estimated gross income, a net income of $1,250,000. The total fixed charges are given as $887,500. The advantages of the consolidation in the way of giving the suburban companies through routes to the business districts, combined with the improvements, extensions, mechanical and electrical consolidations and development of water power proposed, should make this merging of interests a highly profitable one.

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**The Consolidation of Electric Traction and Lighting Companies in Eastern Massachusetts.**—It is now officially announced that some 33 street railway and lighting companies operating in Eastern Massachusetts will be consolidated under one association to be known as the Massachusetts Electric Companies. The concerns consolidated operate the greater part of the street railway mileage north of Boston as far as Nashua, New Hampshire, Newburyport and Gloucester, Mass., and south as far as Fall River, Mass., Newport and Providence, Rhode Island. The street railways have a total of 649 miles of track and operate 1426 cars from 18 power stations, with a total rated capacity of 28,000 h. p. Two electric lighting companies are also included. The consolidation will be in the nature of a trust, a board of 15 trustees, appointed by the certificate holders, holding the title to the controlling interests in the stock of the various existing companies. The Massachusetts Electric Companies has been capitalized at $24,000,000, half of which is in 4 per cent. cumulative shares. The net income of the properties for the last fiscal year applicable to dividends on the shares of the association was $733,000.

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**A New Gas Burner.**—From time to time improvements are brought out in gas lighting devices with widely heralded claims that they will drive electric lighting out of use. The latest is being exploited by the Kern Incandescent Gas Light Company, which has, during the last few days, opened a subscription list of $3,500,000 of its 7 per cent. cumulative preferred stock. The total share capital of the company is $12,000,000, and it appears from the list of prominent bankers and others among its directors that the company is to be a very strong one financially. The device which the company is formed to exploit is an improved burner constructed under the patents of Otmar Kern, which is claimed to give, with incandescent mantles, about twice the candle power obtainable with the ordinary Bunsen burner used in Welsbach lamps. The improvement consists in a construction such that the whole supply of air for the consumption of the gas in the proper ratio is always introduced at the bottom of the burner, no adjusting device being used and no auxiliary air supply to the flame above. The burner also has a grating for intimately mixing the gas and air and a means for partially heating the mixed gases on the regenerative principle before they are consumed. These devices, it is claimed, give about 40 c. p. with a 1-ft. burner and 27 c. p. gas. The officers of the company claim that they have available means of protecting their mantles equal to the Welsbach Company's broadly patented protection by means of a stiffening substance which can be burned off.

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**The Independent Telephone Convention.**—The third annual meeting of the Independent Telephone Association of the United States was held at the Auditorium Hotel, Chicago, on June 26th, 27th and 28th. The following subjects were on the programme: Paper by S. P. Sheerin, of Indianapolis, president of the New Long Distance Telephone Company, of Indiana. Subject: "Value of Long Distance Toll Lines." Paper by C. L. Boyce, manager of the Citizens' Telephone Company, of Grand Rapids, Mich. Subject: "Operation and Maintenance." Paper by Maxine Reber, electrical engineer, of Cuyahoga Telephone Company, of Cleveland, O. Subject: "Essentials of Telephone Construction." Paper by Hon. Harry D. Critchfield, counsel for the United States Telephone Company, of Ohio. Subject: "Development of the Independent Telephone Business."

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**The Electrical Equipment of the Machine Shops of the New York Navy-Yard.**—The United States Naval Department has drawn up the specifications for a power plant for the new shops of the Navy-Yard in Brooklyn, in which power will be distributed electrically on lines remarkably advanced for a government installation. The generating equipment will consist of three 600 h. p. vertical, cross-compound engines, each direct coupled to a 400 kw. 25-cycle alternator, mounted between the cranks. It is explained that this frequency has been adopted as it is that of the Kings County Light & Power Company, indicating that a break down connection may be contemplated. The machines will generate current at low pressure, 220 volts, two-phase, which will be distributed without transformation to the shops, the feeds being short, as the shops will be enclosed by a rectangle about 350x500 ft. in size. The electrical distribution will be complete, each tool requiring more than 5 h. p., having its own independent multiphase motor. Thirteen electric cranes will be installed.

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**The Failure of the Illumination at the Last Great Prize Fight.**—At the Fitzsimmons-Jeffries fight at Coney Island on June 9th an attempt was made to illuminate the scene to a sufficient brilliancy by means of reflecting arc lamps to obtain living-picture films of the various rounds. Twenty-four reflecting lamps were hastily improvised, each intended to consume about 60 amperes. These were arranged on the edge of a platform surrounding the ring and some 30 ft. above its level, the beams being directed downward upon the scene to be illuminated. The work was undertaken very hastily, a temporary generating plant being necessary to give the required power, and at the last moment it was found that it would not carry the load. Less than half the lights were illuminated and those only to a low intensity. The attempt to obtain films was a total failure, causing a loss of many thousands of dollars.

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**The Consolidation of Electrical Interests in Connecticut.**—The Connecticut Lighting and Power Company has, through agents, purchased the properties of the Central Railway and Electric Company of New Britain, the Waterbury Traction Company, the Naugatuck Electric Light Company, the Norwalk Gas and Light Company and the South Norwalk Electric, the Greenwich and the Housatonic Power Companies. The water-power rights owned by the last named company will be developed for the delivery of 30,000 h. p. to the lines of the various companies named, the power being so located that it can be readily and economically delivered to all the cities in the southern and western portions of the State of Connecticut. The purchases, together with the improvements and alterations contemplated, will represent an expenditure of about $6,000,000. Mr. A. M. Young, recently President of the National Electric Light Association, is a prime mover in the scheme.

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### The Electric Light Convention.

The twenty-second annual meeting of the National Electric Light Association passed off in New York City, May 23d, 24th and 25th, with its usual precision, dignity, absence of confusion and general success. The attendance was large, about 300 names being registered. The growing attention to the papers and discussion was continued, the electrical exhibition was an attractive side show, the weather was ideal, the automobile ride proved a most enjoyable novelty, and crowning all was the perfectly appointed trip to Schenectady.

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The one noticeable weak point of the convention was the conspicuous absence of committee reports. The officers of the association would do well to try and remedy this defect in future. The matter presented in papers can often be given or found in other ways, notably in the technical periodicals, and for it engineers are not dependent upon the association. Committee reports, however, have a value and strength, if thought and care is given to them, which cannot be obtained in other ways. One of the vital reasons for an association of electric light men is the work of the committees, and its failure is sure to greatly weaken the association.

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While the papers read at the convention year after year reflect the progress of central station engineering, nothing indicates better the solution of old problems and the rising of new than does the discussion. Perhaps no class of engineers have more perplexing engineering troubles of their own than those in charge of central station work, and immediately following almost every paper of the last convention the discussion settled down in earnest upon some point that is troubling the managers of central stations this year. Most of the old problems, such as multiple rate metering, belted vs. direct connected sets, simple vs. compound engines, etc., evidenced their passing by their absence, the only prominent one remaining being the good old topic of direct vs. alternating current, which this year has new aspects brought in by the development of the rotary converter and double current generator, as well as by the increasing consolidation of rival companies operating direct and alternating current systems.

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Following Mr. H. A. Wagner's paper the discussion on this point was precipitated by the propounding of the problem: Which is to be the ultimate system, and shall a central station manager giving both kinds of current make his extensions from his direct or alternating current lines? The general opinion seemed to prevail that if the alternating current motor and especially the single phase motor could be developed to give good service on direct geared elevators, the problem would be easily answered. It was pointed out that one of the greatest difficulties heretofore in alternating current motor work, the disturbance of voltage regulation, is not so much due to the fault of the motor itself as due to the fact that alternating current machines have, as a rule, been small with poor regulation and the lines have been built of any size wire that came handy, while direct current systems have been run with larger machines worked in parallel, supplying their loads over copper carefully proportioned for the proper drop.

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Following Mr. W. S. Barstow's paper the discussion revealed another alternative now perplexing to engineers, viz., the use of steam or electrical auxiliaries. The net result of what was said upon this subject indicated the opinion that for condensing plants without economizers the steam auxiliary is the proper thing, as all its losses can be returned through the feed water; while for non-condensing plants or plants with economizers, there is an opportunity for a considerable saving of fuel by the use of electrical auxiliaries.

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Following Prof. W. L. Robb's paper the discussion evidenced the desire of central station men to feed their arc lights directly or indirectly from the same machines that generate power for their other loads, and thus to do away with the belting and countershafting of series arc machines and possibly with the machines themselves. The series alternating arc is exciting at present the greatest interest, as it apparently offers the cheapest and simplest method of accomplishing this result. Its use, however, has as yet been so limited that central station men hestitate its adoption, awaiting to see what the result of time will be on the few installations now in service.

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On the subject of the ageing of transformers, the papers of Prof. Goldsborough and Mr. G. W. Hubley showed two very felicitous conclusions. The first showed that in transformers as now made the ageing is practically negligible, and the second described a means of remedying that of the older types.

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### The Proper Size of Transformers for Secondary Mains and Network.

Now that large transformers, with secondary mains for feeding the premises of several or many independent users of central station energy, have come to be accepted practice in place of independent house to house transformers, it requires considerable judgment to determine the best size of transformer to use for any such load. It is difficult to estimate how many of the lights wired to one transformer are likely to be in use at one time,

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or what is more to the point, how many are likely to remain in service for a sufficient length of time, especially during warm weather, to injure the transformer through overheating. If safety is the only consideration and a generous size is chosen the efficiency on average loads is considerably reduced, and if on the other hand a transformer too small is put in service, it or its fuses may be burnt out or at least the ageing of the iron will be hastened through dangerously hot running.

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A handy means of solving this problem is available in the maximum demand meters, especially those of the thermal type, such as the Wright meter, now on the market for another purpose. By placing one of these in the transformer primary and leaving it there during a representative interval of time a record will be obtained of the maximum amperes taken during that time, whereby the fitness of the size of the transformer in service may be determined. This simple kink in central station engineering is of particular value when the ability of a transformer to carry its load comes into question owing to the growth of business.

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A similar use of the same instrument which is of even more value, is the determination of the proper grouping of transformers located at different points and interconnected by a secondary network either on the two or three wire system, which practice is rapidly growing in favor in districts of congested loads. It is a phyiscal impossibility to determine without some measurement of this kind whether a 10 kw. transformer at a street intersection is properly dividing the load with a 100-light transformer at the next corner. By the use of maximum demand meters in the primaries of the two transformers the division of the maximum can readily be determined and corrections made if the division overloads one and underloads the other, either by relocating one or the other of the transformers at different points on the secondary mains or by rearranging the copper of these mains

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**Constant Current Transformers.**

The alternating current arc lamp has never been very popular in comparison with its direct current prototype, partly on account of difficulties with the governing mechanism of the lamp, which have now been overcome; partly on account of the noisy hum that early alternating current lamps emitted, which also has been remedied; and partly on account of the 25 to 40 per cent. lower output of light per unit input of energy and the poorer distribution of the light given out, which appear to be inherent objections to the alternating current arc as compared with the direct current. In spite of these difficulties the desire to operate arc lamps on alternating current circuits has stimulated the perfection, during the last two years, of many different makes of constant potential enclosed lamps for alternating current circuits.

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One system of series alternating arcs on independent constant current machines has been developed but never put into very wide use, and in one large station in this country, that of the Missouri Edison Company in St. Louis, alternating arcs are run in multiple series banks across the high tension bus bars of large constant potential machines. The advantages of consolidating the various loads of a station upon one class of generators have naturally led to a general desire for some means of regulating alternating current series arc circuits run from constant potential mains, which means can be obtained by what are called constant current transformers, the term meaning that when supplied with constant potential on the primary sides they give constant current to their secondaries.

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There are two fundamentally different means of obtaining this result. One would be by means of cutting in or out the turns of either the primary or secondary, which would involve mechanical apparatus of considerable complexity and troublesome contacts. The other is the use of transformers of considerable self-induction and movable coils, designed to be operated by the repulsion effect, and transformers of this kind have lately been perfected, standardized and put on the market for this purpose. Descriptions of transformers of this type and their performance in Hartford, Conn., will be found on other pages of this issue.

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Naturally the power factor of such a transformer is low, in fact the transformer is specially designed for what would be considered bad regulation for constant potential work. There is no interleaving of primary and secondary and magnetic leakage is absolutely depended upon for regulation. Tests made in Hartford have shown a power factor at maximum load of 80 per cent. which, of course, falls off rapidly on lower loads. Tests have also been made of the efficiency, showing a maximum value of 96 per cent., a figure closely comparable with that obtained on constant potential transformers of the same capacity, viz., about 40 kilowatts. This efficiency, however, naturally falls off somewhat more rapidly on these transformers than on constant potential transformers, as the load goes down, owing to the great length of the magnetic circuit and the consequently high iron losses. The copper losses of the secondary are also the same no matter what the load may be.

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No central station engineer should make an attempt to use such transformers on small machines, at least unless the machines are exclusively devoted to that load. On account of the large amount of lagging current their magnetic leakage introduces, such transformers would be likely to pull down severely the voltage of a machine which they alone would load. For instance, a 100 light transformer of this kind, having a capacity of about 40 kilowatts, would badly disturb an old type unitooth composite wound alternator of 100 kilowatts. Where, however, the machines are large, of several hundred kilowatts capacity each, of close regulation and running in batteries in parallel with each other, transformers of this type may be safely put upon them to the extent of at least 20 or 30 per cent. of their rated output.

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**Electrical Installations in the West Indies.**

There will be found on the first few pages of this paper a description of an electrical transmission and railway plant in Kingston, Jamaica. The peculiar climatic conditions and the high prices of some structural materials involve features in this plant which are quite different from installations for the same purpose in this country. Among other things the poles of the transmission line are of steel and the power house itself is built entirely of steel and concrete.

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There may be expected during the next few years an inrush of electrical plants to the new dependencies of the United States in the West Indies. Indeed, energetic prospectors have already determined the most valuable locations and rights and only wait the settlement of governmental conditions, upon which depend their franchises, before they take further steps. The engineers of such proposed improvements would do well to examine the most recent and improved West Indian electrical plants, at the head of which is that of the West India Electric Company, of Jamaica.

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## THE APPARATUS FOR WIRELESS TELEGRAPHY.

BY PROF. JEROME J. GREEN.

The apparatus for demonstrating the effectiveness of telegraphing by means of Hertz waves is comparatively simple. In the experiments recently conducted at the University of Notre Dame all the essential parts of the sending and receiving stations were found in the regular equipment of the electrical and physical laboratories, except a few details which were constructed in the workshops by the students.

It has been known for several years that electric waves are propagated from an insulated conductor when this conductor is rapidly charged and discharged in such a way as to produce a series of very sudden disturbances in the surrounding ether. The waves are said to travel with about the velocity of light, but their length is much greater than the length of light waves, and this length depends on the character of the spark produced at the discharging terminals. These terminals, as used in wireless telegraphy, are always spherical in shape, with great variations as to size.

These electric waves of various lengths may be refracted or reflected like the waves of heat and light. They pass through many substances but are absorbed or reflected by metals.

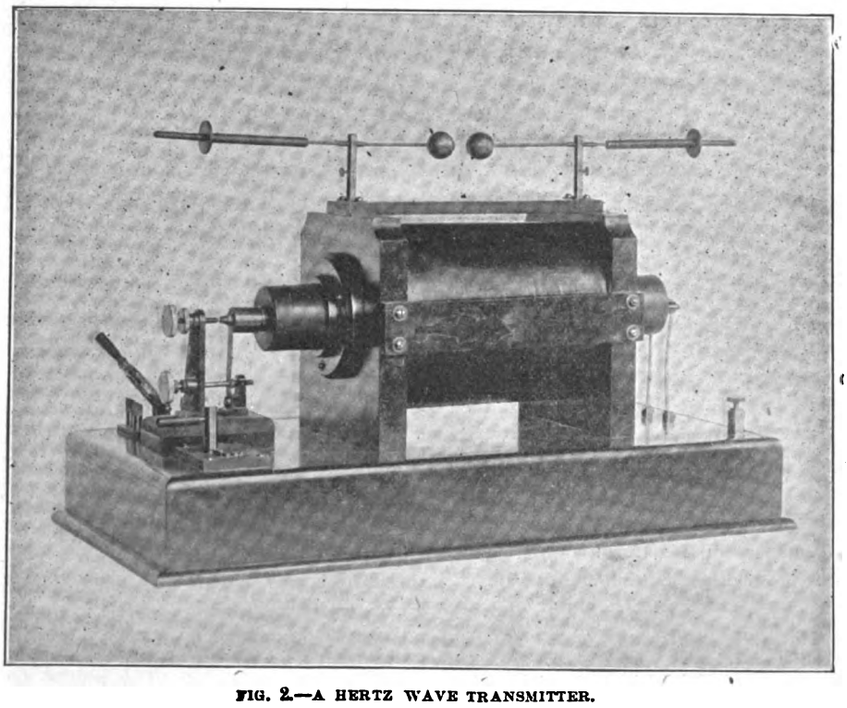


FIG. 2.—A HERTZ WAVE TRANSMITTER.

The parts required for a complete sending station are an induction coil capable of producing a stream of sparks from one to ten or more inches in length. A smaller coil will of course answer if the receiving station is located close to the sending apparatus—a suitable primary or secondary battery to operate the coil and a discharger or oscillator. The oscillator may be two large metal spheres placed about half an inch apart on insulating supports. The space between them is sometimes filled with a heavy petroleum oil, but this is not essential. Additional spheres or plates may be connected with each of the large spheres between which

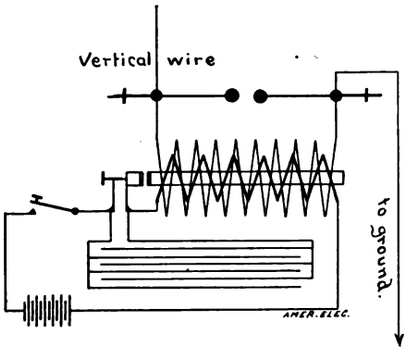



FIG. 1.—CIRCUITS OF TRANSMITTER.

the discharge takes place. These additions increase the capacity of the oscillator and change the character of the spark produced.

A simpler and more easily constructed oscillator is the vertical wire with a metal sphere at its upper end, in connection with two small spheres about an inch in diameter. This is the apparatus Mr. Marconi used. The lower end of the vertical wire is attached to one of the spheres and the other is fastened to a steam or water pipe.

An easy way to make this form of oscillator is to drill holes in two small metal spheres and put these spheres on the adjustable points, with which all induction coils are supplied, at the terminals of the secondary windings.

The vertical wire should be attached to one of the terminals of the secondary coil, and the ground wire to the other. (See Fig. 1). Then adjust the distance between the spheres, and the tension on the vibrating interrupter spring until a stream of thick, white, noisy sparks is produced when the primary switch is closed.

For the receiving station there is needed a coherer with a decohering tapper, a sensitive relay, and a sounder or a Morse recorder.

The coherer is, of course, the essential part of the receiving station. It may be made from a small glass tube, of, say, one-eighth of an inch internal diameter, and it may be about an inch and a half or two inches long. Into the ends should be fitted brass rods, and these plugs of metal should have a space between their ends near the middle of the tube, which space can be increased or decreased in length by sliding out and in one of the metal plugs. To complete the coherer a small quantity of filings of metal, such as silver or nickel, or a mixture of these metals, is put in the space between the plugs in the glass tube. Filings from the ordinary five-cent piece will answer very well.

This contrivance has the property of changing its resistance when it is acted on by the waves. A space in such a tube one-fourth of an inch in length, loosely filled with filings in their normal condition, will have a resistance of several megohms, but when the waves from the sending station strike the vertical wire attached to one of the terminals of the coherer the resistance of the coherer falls to about ten ohms. The coherer is put in circuit with a high-resistance relay, and a dry battery of one or two cells. When no waves are passing, the coherer has so high a resistance as to virtually open this circuit; but when the action of the waves begins, the decrease of the resistance closes the circuit, and the armature of the relay is drawn down and closes the circuit on a sounder, or on whatever we wish to add to the receiving set. The resistance of the coherer remains at this low value even after the waves have ceased to strike the vertical wire, but it becomes very high again when the filings are shaken. A little tapper like that on an ordinary electric bell is made to strike the side of the tube for this purpose. The relay in circuit with the coherer may close a circuit to operate such a decohering tapper or the filings may be shaken by tapping the tube with a lead pencil or by other mechanical means.

From the diagram, Fig. 3, it will be seen that the minute oscillating current produced in the vertical wire set up by the passing of the waves has the choice of two paths to earth; through the coherer, C, or through the relay, R. To prevent its passing to the relay and leaking across through the metal, well insulated choking coils A & A are placed in the circuit with the relay. The rubber-covered spools of a four-ohm telegraph sounder will do for these coils. The small current is then forced to go through the filings to ground, and this causes them to cohere as long as it is passing, even

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though they are shaken. It is well to put some non-inductive resistance (such as the lamp shown in the diagram) across the points of the vibrating tapper and the tongue of the relay to prevent a spark there. It is especially important that the spark be prevented at the tapper, as it is so close to the filings that if considerable sparking occurred here it would set up waves which would cause the filings to cohere to some extent and prevent the decohering action of the tapper. The great difficulty in the first experiments at Notre Dame was to make the filings decohere quickly. If this action is not prompt it is impossible to make dots and dashes so that they can be distinguished.

Fig. 4 shows the coherer tube mounted on hard rubber supports on the top of the metal cover of an ordinary buzzer. An extension from the armature of the buzzer reaches through the cover and strikes the tube.

We employed in all our experiments an eight-inch induction coil of American make, with a heavy Apps vibrating circuit breaker. The current for the primary was furnished by a battery of six five-ampere storage cells. The double-pole jack-knife switch on the base of the coil served to open and close the circuit at first, but later a heavy telegraph key with special contacts was used. The coil is shown in Fig. 2.

An ordinary one hundred and fifty-ohm telegraph relay was employed in the receiving set for distances up to one-half of a mile, then a similar one of fifteen hundred ohms' resistance, with a lighter armature, was substituted for the ordinary relay, and it gave good results at distances of about two miles. Later a more sensitive relay was made by adding platinum contact points to the needle of a portable galvanometer of the D'Arsonval type. This responded more readily than either telegraph relay. Five small dry cells were used to operate relay, tapper and sounder.

We first suspended an ordinary No. 14 rubber-covered wire about ten feet long

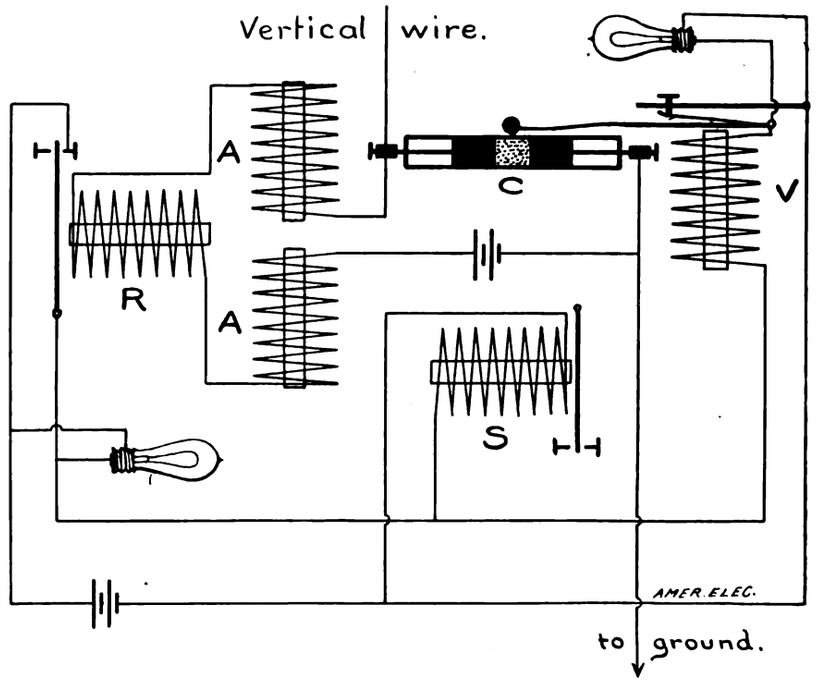



FIG. 3.—CIRCUITS OF RECEIVING APPARATUS.

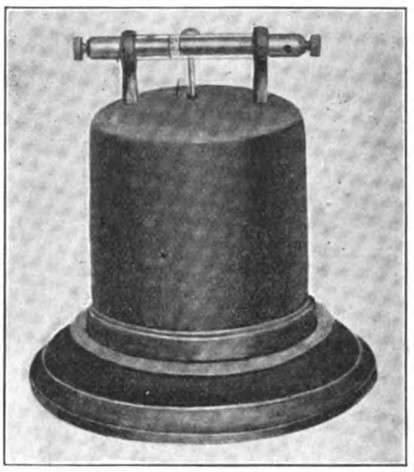


FIG. 4.—COHERER AND TAPPER.

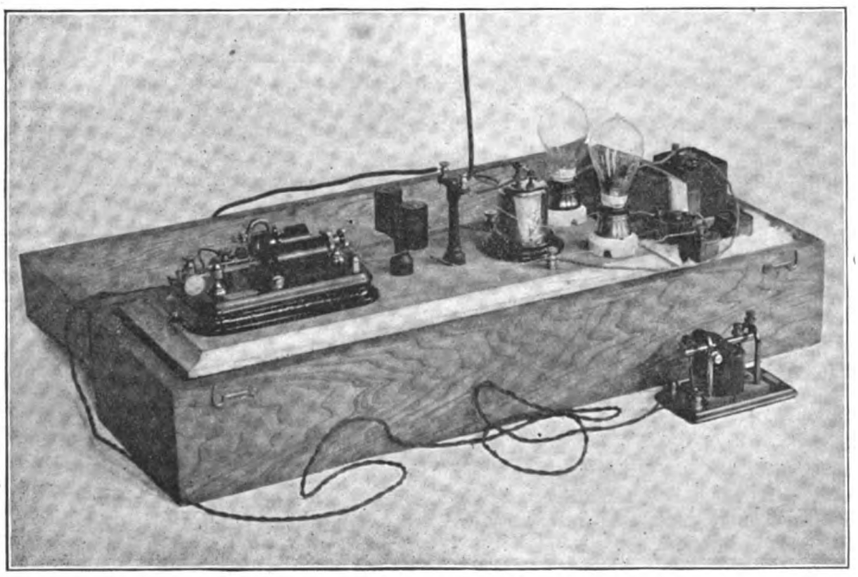


FIG. 5.—RECEIVING APPARATUS COMPLETE.

from the ceiling of the physical laboratory and attached its lower end to one of the binding posts at one of the terminals of the secondary of the induction coil; the other terminal was connected to a steam pipe near by. These binding posts also carried the adjustable pointed rods, on the ends of which were placed the polished brass spheres one inch in diameter. The tension of the vibrator springs was adjusted so that a spark about an inch long passed between the spheres when the circuit was closed. A similar wire about six feet long was suspended in an adjoining room with its lower end connected to one end of the coherer. A wire from the other end of the coherer was attached to a steam pipe. When the circuit was closed on the induction coil the filings in the tube appeared to be arranged in strings or chains as when they are strongly magnetized. Their resistance fell to about six ohms. A very vigorous shaking was required to cause them to resume their normal condition of high resistance. Cohesion took place in the tube of filings, but not so strongly, when the ground connection was removed from the coherer.

The receiving apparatus was then placed in a building about one hundred feet distant, and ground connections were made to a steam pipe. The same short vertical wire was used and the relay closed every time the coil was worked. The windows and doors of both buildings were closed. Next a wire about twenty-five feet long, with a metal sphere at its upper end, was suspended from the roof of Science Hall. The lower end was brought through a window and attached to the induction coil, and ground connection was made from the coil to a steam pipe. A similar wire and sphere were suspended from a window in the top floor of a three-story building across the campus, at a distance of about two hundred yards from the sending station at Science

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Hall. The lower end of this wire was also brought through a window and attached to the coherer; the ground connection was made to a steam pipe. The impulses in this case were received as strongly as when we were working from one room to the next with the short wires. The receiving apparatus was next placed at a building about five hundred yards from Science Hall. The vertical wire was about twenty-five feet long and ground connection was made to a water pipe. The coherer responded readily at this increased distance. Its normal resistance, as measured with a Wheatstone bridge, was very high, more than a megohm. The tapper was then disconnected to prevent its shaking the filings, and when the circuit was closed on the induction coil at the sending station the resistance of the coherer instantly fell to ten ohms and remained at this low value until shaken.

The induction coil was next placed at the foot of a steel flag pole about one hundred and twenty-five feet high. The vertical wire and sphere were suspended from the top of the pole on a wooden bracket, which held the wire about ten feet from the pole. Ground connection was made to the base of the pole. The receiving apparatus responded at distances up to two miles when impulses were sent from the station at the flag pole.

In the last experiments at Notre Dame the vertical wire and sphere were suspended from a high church tower and the induction coil was placed about thirty feet up in the tower. The lower end of the vertical wire was brought through a window and attached to the coil. Ground connection was made to a water pipe. The active length of wire here was about one hundred and fifty feet. The impulses were received strongly at a distance of three miles, about one mile of this space being occupied by the city of South Bend. Another trial to Mishawaka, a distance of about six miles across the country, resulted in failure.

Trials were made in Chicago among the steel buildings and overhead wires in the business district. When the sending station was located at the Polk street railroad station and the receiving apparatus at the "Tribune" building, a distance of about three-fourths of a mile, the relay failed to respond when the coil was operated. In this case a line drawn from the sphere at the top of the wire at the sending station to the similar sphere at the top of the wire at the receiving station would be intercepted by many electric light, telephone and telegraph wires running in every direction. These wires apparently absorbed the waves, for in another trial from the Monadnock Block to the "Tribune" building, there was a clear space between the spheres at the tops of the wires. The receiving apparatus responded strongly. The distance in this second experiment was about half that at which the first trial was made.

Later the sending apparatus was set up at the life saving station at the mouth of the Chicago river, and the receiving set was placed on a tug. One wire and sphere were suspended from the end of a pike pole lashed to the railing on the lookout of the station, giving an active length of about forty feet. Ground connection was made by attaching a wire to an iron pipe placed in the water. The other wire and sphere were suspended from a short mast on the tug, giving an active length of about thirty feet. Ground connection was made by attaching a wire to a piece of iron hung out over the stern of the tug. The impulses caused the

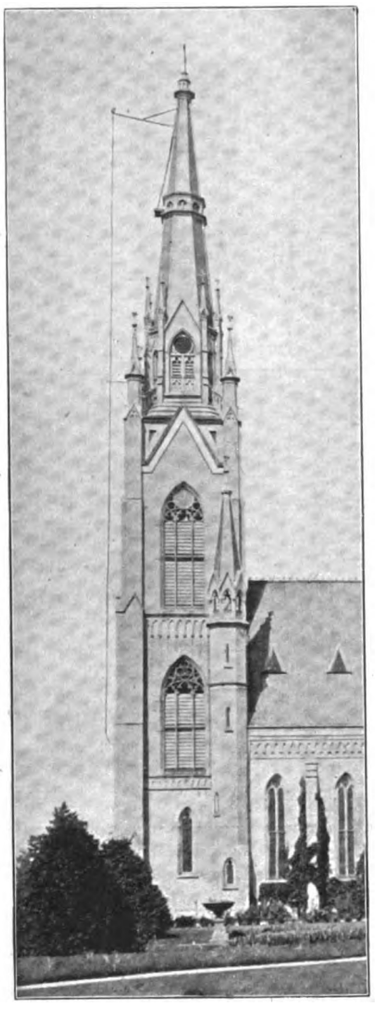


FIG. 6.—THE TRANSMITTING WIRE AT NOTRE DAME.

sounder to operate very strongly until a distance of about two miles out in the lake was reached, when the sounder ceased to respond.

It seems from these trials that it is much easier to operate over water than over land. This result is also indicated by the great distances Mr. Marconi has attained over water, while Ducretet, with the best instruments that skill can produce, has succeeded in sending messages only about five miles over the city of Paris, where there are no overhead wires to interfere. Our experiments with crude apparatus show that it is quite easy to reach short distances, but it is quite difficult to adjust all the parts to make the dots and dashes accurately.

## AMERICAN TELEPHONE PRACTICE.

### TESTING.*

BY KEMPSTER B. MILLER.

Tests of telephone lines, whether of bare wire on poles or of overhead or underground cables, may be divided into two general classes:

First: Those which are for the determination of the existence of certain conditions, without the necessity of measuring quantitatively the extent to which those conditions exist. In other words, rough tests for the determination of grounds, crosses or breaks, usually made with instruments such as the magneto-bell, telephone receiver and battery, and a few other such simple but often in the hands of an experienced person most effective instruments.

Second: Those for not only determining the existence of certain conditions, but also for their quantitative measurements. These require the use of different and more intricate instruments, and in many cases the operator must be possessed of a fair degree of mathematical training combined with an ingenuity for meeting and mastering unusual problems that arise under different conditions.

The magneto testing set is the most important instrument in making tests under the first class. Such an instrument usually consists of a powerful magneto-generator so wound as to enable it to ring its own bell through a resistance of from 25,000 to 75,000 ohms. A powerful magneto-telephone is carried on the outside of the case in suitable clips, and may be switched in circuit alternately with the generator by a small hand switch. This magneto-telephone serves as both transmitter and receiver, and enables the lineman or other party to communicate from a pole top or man-hole with any other party on the circuit. Frequently these sets are made to include microphone transmitter and battery; but, inasmuch as the instrument is seldom if ever used to talk over very long circuits, the extra weight of these is considered in most cases undesirable. A small, inexpensive galvanoscope or current detector will also prove very convenient.

In testing for a ground on a wire, whether it be in a cable or bare and on poles, make sure that the far end of the line is open and then connect one terminal of the magneto-bell to the near end of the line and ground the other terminal. The ringing of the bell would seem to indicate that the circuit was complete and the line grounded in this case, but this is not always true, and this test must therefore be relied on only with caution. The static capacity of a long line or of a comparatively short length of cable will often allow enough current to pass to and from the line in charging and discharging to ring the magneto-bell.

For testing out local work where there is no room for this capacity effect, the magneto-bell is invaluable.

* From a book to be published by the American Electrician Company.

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A more reliable means of making tests for grounds or crosses is to connect the current detector in series with several cells of battery and to ground one terminal. Then with the other terminal make contact with the near end of the line. A kick of the needle will take place in any event on closing the circuit, due to the current flowing to charge the line, but a permanent deflection will indicate a ground.

In testing for a cross, as for instance with some other wire in the line or cable, one terminal of the magneto-bell or the galvanoscope and batteries should be connected to the wire under test and the other to all the other wires in the same

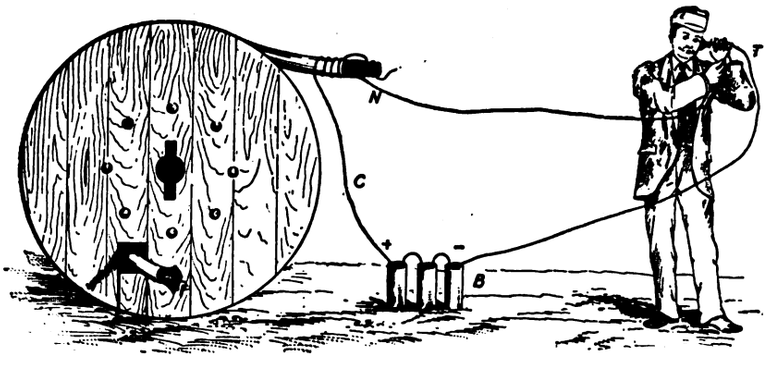



FIG. 1.—RECEIVER TEST FOR CROSSES AND GROUNDS.

lead for which purpose they are bunched. In case it is not convenient to bunch them, however, the test may be made between the suspected line and each of the others in succession.

Another and perhaps still more simple method for determining a cross or ground is one described in Roebling's pamphlet on Telephone Cables, and illustrated in Fig. 1, as applied to the testing of a cable before it has been unreeled.

N represents the near end and F the far end of the wire being tested. B is a battery of about three cells. T is an ordinary telephone receiver. The wire, N F, is carefully separated from all the others at each end.

At the near end all the wires are stripped of insulation and except the one under test are connected together and also with the sheath. The wire, C, connects the sheath to one side of battery, B, and the other side of battery is connected to one side of telephone receiver, T. The testing man rapidly taps with the wire, N F, the unoccupied binding post of the receiver, T. The first tap will produce in the receiver a distant click, and if the cable is long there may possibly occur a second faint click, but if the wire, N F, is perfectly insulated, no more sound in the telephone will follow the tapping. If, however, the wire, N F, is crossed with any wire in the cable, or with the sheath, every tap will be followed by a distinct click, and if there is moisture in the paper, making a partial connection, clicking sounds will occur, which are loud or faint, according to the amount of moisture present.

The philosophy of this method of testing is very simple, and serves to make the operation more readily understood.

When the wire, N F, is first connected to battery, it becomes charged. During the time it is filling with electricity a current flows. This current passes through the coil of the receiver and causes the click. If the wire is well insulated, the second tap, immediately following, finds it charged, or nearly so, and there is, therefore, no click, or a very faint one. If, on the contrary, the wire under test is crossed with any of the other wires, or imperfectly insulated from them, or from the sheath, the wire will immediately discharge itself through the cross to ground and there will be a flow of current at every tap, and consequently a continuous clicking. If a conductor in a perfectly insulated cable is very long, two or three taps or a long first contact may be necessary to charge it completely.

If the cable is in place or if it is a bare aerial line that is being tested this same method may be used. In case of a new cable it is well to test every wire in this manner, and therefore the wire, N F, should be put aside and another slipped out of the bunch and tested in the same way, and so on until all have been gone over. If any of them are found to be in trouble, it is well to carefully inspect the exposed ends to be sure they are properly cleared from each other and from the sheath. If it is still found to be defective, it should be plainly tagged.

In the manner just described, twenty-five minutes with two men should be ample time for testing one hundred wires, the testing operator listening and his helper attending to the connection of the different wires at N.

For this test as well as many others it is very convenient to use a regular operator's receiver and head band, as it will save the tester a very tired arm at the end of a long test.

The continuity test, or test for broken wires, may be made with the same simple instruments. The wires to be tested should all be grounded at the far end. At the near end, one pole of a magneto-bell, or of the battery and galvanoscope, or of the receiver, should be connected to ground and the other terminal connected successively to the terminals of the line, which, of course, should all be separated. A ring in case of the magneto, or a deflection of the needle in the case of the galvanoscope, or a continuous clicking in the receiver, will indicate that the wire is continuous. The same precaution as previously pointed out must, however, be observed with the magneto-bell. This same test for continuity is well illustrated in Fig. 2, in which case a vibrating bell instead of the receiver or galvanoscope is used.

In testing a cable all defective wires should be marked, "crossed," "grounded" or "broken" at the end at which they are tested. The corresponding ends of the tagged wires at the other end of the cable should then be found and similarly marked.

If there are not the requisite number of good wires in a new cable is should be rejected.

It is often desirable to be able to pick out a certain wire at some intermediate point in an open cable, or in a large bunch of insulated wires, in order to establish a branch connection. This is easily done by the foregoing methods if the cable is to be cut, but frequently this is not the case. It may be done without cutting by the following simple method: Ground the wire or wires desired at the distant end, being sure that these wires are free from all the others at both ends.

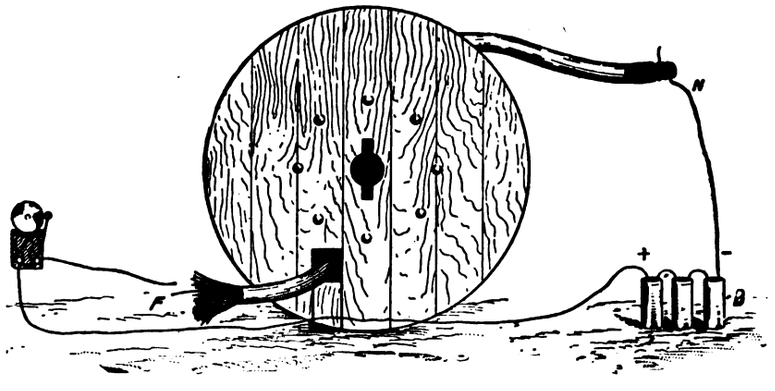



FIG. 2.—CONTINUITY TEST.

Then having loosened the bunch of wires at the point at which the branch is to be taken off, test each by means of a needle-pointed instrument, connected to ground through a bell or receiver and battery. The needle-point can readily pierce the insulation and make good contact with the conductor within. A knowledge of this very simple test will often save an immense amount of trouble.

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## STEAM AND WATER REDUCING VALVES.

Boiler-room economy calls for the generation of steam at high pressures, but many appliances necessitate the use of the vapor at a pressure much lower than that at which it can be profitably generated and used in engines. Undoubtedly, the first attempts in this direction were to throttle the steam by means of a valve

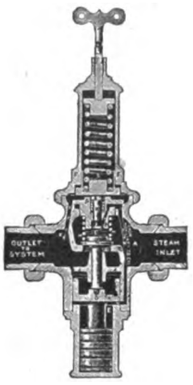


FIG. 1.—MASON VALVE.

in the supply pipe, adjustments being made thereto when necessary, as determined by reference to a pressure gage connected with the low-pressure side of the throttling valve.

Such a crude piece of apparatus would soon be improved by making the low-pressure steam open or close the supply valve, according as the consumption increased or diminished. Some sort of a piston and cylinder, or diaphragm arrangement would naturally suggest itself for this purpose, and such devices are used for that purpose in a great multiplicity of form and arrangement, as shown by the following illustrations and text.

One of the well known forms of reducing valve is shown in Fig. 1, which is of

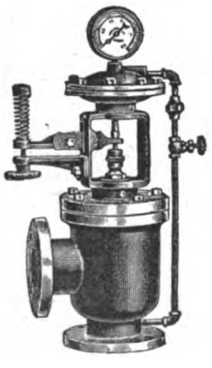


FIG. 2.—FISHER VALVE.

the piston type, and is known as the Mason valve, being made by the Mason Regulator Company of Boston, Mass. In this valve steam enters from steam inlet through an auxiliary valve which is normally held open by a spring. A differential piston is then raised by the pressure of the steam, and in turn opens the main valve and admits steam until the phosphor bronze diaphragm is raised at the point determined by the tension upon a key adjusted spring. Then the auxiliary valve is closed, thereby seating the main valve by means of the initial pressure. This action is repeated when the low pressure drops below the stated point.

Fig. 2 shows a type of diaphragm reducing valve in which the variable adjustment is also by setting a spring, although another form of this valve is made with a weight substituted for the spring. The weight style is particularly adapted for very low pressures, and it is claimed that the pressure will not "sneak up" as boiler pressure increases, when this valve is used. By connecting the diaphragm supply pipe with a pressure tank this reducing valve is readily made to answer as a pump governor. This valve is made by the Fisher Governor Company, Marshalltown, Iowa.

Valve makers find it necessary to employ special methods to prevent sticking and friction. One way of doing this is to dispense with all stuffing boxes, thereby enclosing both spring and diaphragm in

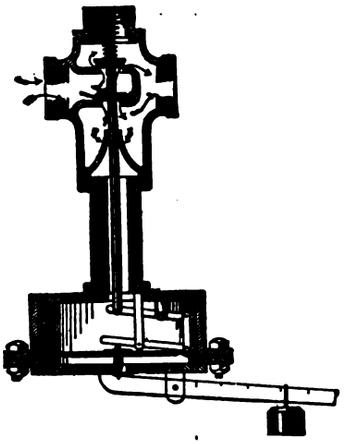


FIG. 3.—A SENSITIVE VALVE.

the same chamber on the low-pressure side of the valve. Fig. 3 shows this as executed by the Kitts Manufacturing Company, Oswego, N. Y. The valve is fully balanced and a spring is used to seat the discs against the boiler pressure. The diaphragm is so connected with the valve stem, by means of compound levers, that pressure against the diaphragm also tends to close the balanced valve. At the same time the compound lever gives a long movement of the valve with a very short movement of the diaphragm.

A valve is shown by Fig. 4, which dispenses with all springs, diaphragms and packing. It is known as the Davis Pressure Regulator, and is manufactured by G. M. Davis, Chicago. It is also catalogued by the Crane Company of the same city. The valve stem carries a piston arrangement in the cylinder, shown in the bonnet, and a yoke device connects the piston with a double-ended lever to which two weights are attached, thereby allowing the necessary pressure adjustments to be made at will. A dash-pot is shown, and is used only when there is a vibration or pulsation of steam. This device is omitted when there is no pulsation of pressure.

In some spring controlled reducing valves, tension on the diaphragm is not uniform. A compensating device is shown in Fig. 5, whereby the diaphragm is made independent of the amount of spring compression. This is done by the toggles shown in the engraving, whereby the increasing power of the spring is com-

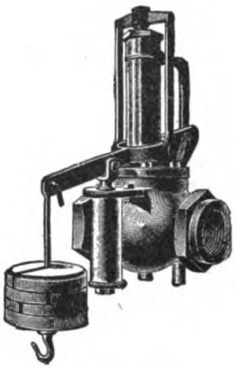


FIG. 4.—THE DAVIS PRESSURE REGULATOR.

pensated by the increasing power of the toggles as their angle is reduced. A system of levers is also employed to enable a small diaphragm to control a large valve.

This valve, which is made by the Foster Engineering Company, Newark, N. J., has a device which allows both discs of a double-seated valve to remain tight under varying temperatures. This is done by making the angle of the upper disc and seat obtuse, and of the lower acute, but still of such angle that it cannot "stick." The lower disc finds its bearing by diametrical expansion, due to the temperature of the fluid.

All diaphragms, springs and packings are dispensed with and there is little possibility of sticking in the valve shown by

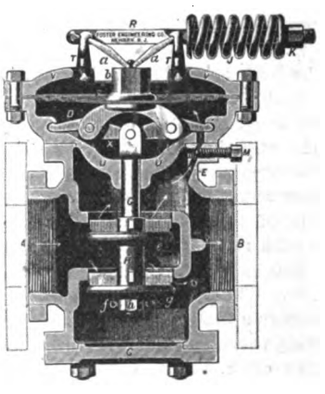


FIG. 5.—FOSTER PRESSURE REGULATOR.

Fig. 6. It is noiseless in action, and there is no dash-pot or oil cylinder. In fact, as illustrated, the Monarch Pressure Regulator, made by the Van Auken Steam Specialty Company, Chicago, Ill., is a simple positive form of reducing valve with several valuable features.

A piston, acting against a weighted lever, furnishes the working power, and

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the lever is connected to the valve stem by means of a long sleeve which fits outside an elongated bonnet, thereby avoiding a stuffing-box. The lever may be fastened to any part of the sleeve, thereby allowing the lever to be adjusted at an angle therewith, so as to avoid steam pipes, beams or other interferences. The lever is also swivelled so that it can be turned at any angle. A screw-stem and hand-wheel at the bottom allow the valve to be closed tight at will.

Types of both high and low-pressure reducing valves are shown by Fig. 7. These valves are made by Kieley & Mueller, New York City. The high-pressure valve is operated by low-pressure steam acting against a piston, the opposite side of which is open to the atmosphere. Steadiness is imparted by a piston upon the lower end of the valve-stem, said piston working in a cylinder filled with water of condensation. The "atmospheric piston" is made tight by Garlock's or Crandell's packing, and is claimed to be almost frictionless.

In the low-pressure valve there is a diaphragm instead of a piston, the stuffing-box being dispensed with. The method

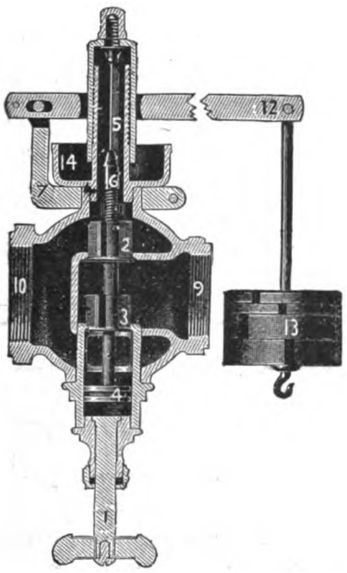



FIG. 6.—MONARCH PRESSURE REGULATOR.

of construction is so clearly shown by the engraving that no further description is necessary, except to state that the terms "high" and "low" pressure mean, in connection with these valves, above 15 pounds, and below that pressure, respectively.

Another valve, designed for reducing steam to an extremely low pressure, for use in vacuum systems of heating, is illustrated by Fig. 8, and made by the Standard Steam Specialty Company, New York, and is known as the "Utility Reducing Pressure Reducing Valve," although the purpose of such a title does not appear upon an inspection of the valve.

The construction is about the same as that already described for diaphragm valves, the diaphragm being very large in proportion to the steam inlet. A double-weighted lever furnishes means of adjustment. One peculiarity of this valve is that it is flanged and comes bolted to a pair of companion flanges, a fact greatly

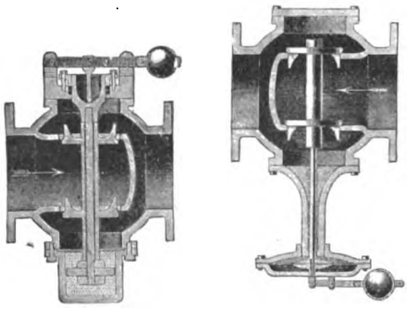


FIG. 7.—HIGH AND LOW PRESSURE KIELEY VALVES.

appreciated by the workmen who have to put up or keep in repair steam fittings of this class.

A double cylinder, double piston pres-

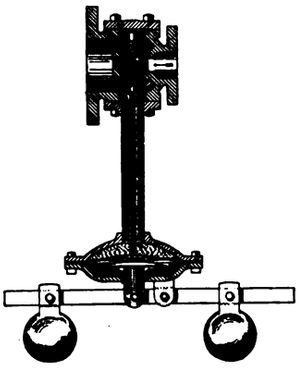


FIG. 8.—UTILITY REDUCING PRESSURE REDUCING VALVE.

sure regulator, made by the Newark (Ohio) Regulator Company, is the subject of illustration in Fig. 9. This valve and those next described are designed for

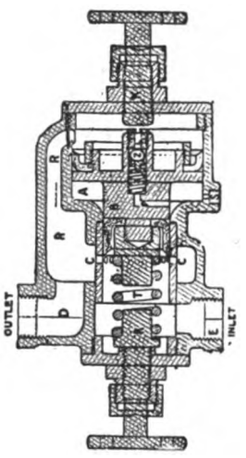



FIG 9.—NEWARK PRESSURE REGULATOR.

reducing water pressure rather than for steam, although they may be used for that purpose if desired. The fluid under pressure acts upon the small end of the piston, escapes through the port and acts upon the large piston, which, when a certain pressure is reached, is forced back, covering the ports and reducing the pressure on the outlet side of the regulator.

The small relief valve shown at the right of the engraving may be set at any desired pressure, and any excess over the stated amount forces the valve open, allowing enough fluid to escape that the pressure may be relieved. As none of the valves come against seats, all jarring noises from that cause are impossible, and the entire working of the valve is very easy and noiseless.

The Mason Water Reducing Valve, as depicted by Fig. 10, is a double-spring appliance with screw adjustment, and is controlled by a diaphragm. This valve is designed for use between a high pressure street service and low pressure for houses. Inactive water enters from the right, passes through the valve, which is held open normally, by action of the lower spring. Water also enters the diaphragm chamber through the communicating passage shown, and when the desired pressure has been accumulated the diaphragm is forced down and seats the valve. When the pressure lowers in the system the springs again force the valve open and the action noted is again repeated.

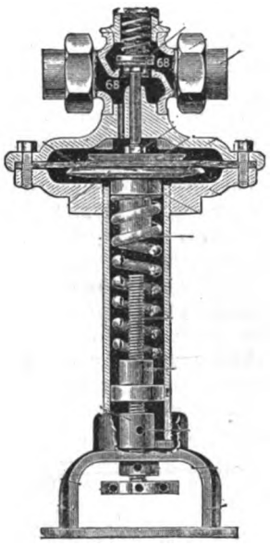



FIG 10.—MASON WATER REDUCING VALVE.

About the only difference between a pressure regulator and a pump regulator, is in the fact that the diaphrgm or controlling piston is connected to the water delivery in the latter named appliance, and to the low-pressure steam pipe in case of the former. Many pump regulators make excellent reducing valves; in fact, all can be thus used if desired, and some water regulators can likewise be thus used.

Quite a number of the steam and water pressure regulators above described can be used to advantage as pump regulators, but not all, and that comprises the difference between the two appliances, viz.: All pump governors may be used as pressure reducers, but all reducing valves cannot be utilized as pump governors.

One of the interchangeable type is il

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lustrated by Fig. 11, and is made by the Watts Regulator Company, Lawrence, Mass. This appliance consists of a double seated valve with a long vertical stem which passes through a partition separating high from low-pressure steam—or water. There is a small pipe which connects the water well with the point where the reduced pressure is required. It is the partition and connecting pipe which enables this valve to do double duty, as noted

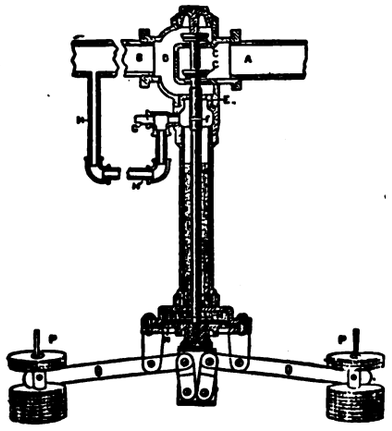


FIG. 11.—WATTS PRESSURE REGULATOR.

above. The ratio of pressure reduction is regulated by the double levers and variable weights shown at the bottom of the engraving. This form is recommended where the reduced pressure exceeds 20 pounds. For less than that pressure a single lever regulator is made.

Another pressure regulator which has a similar connecting pipe between diaphragm and low-pressure piping, is shown by Fig. 12. This regulator was originally patented by John Acton, 193 Worth Street, New York City. It has a balanced double valve which is connected to the diaphragm by means of a system of levers, in which there is an adjustment to make the valve open earlier or later, as desired. This adjustment may also be used to a limited extent for varying the

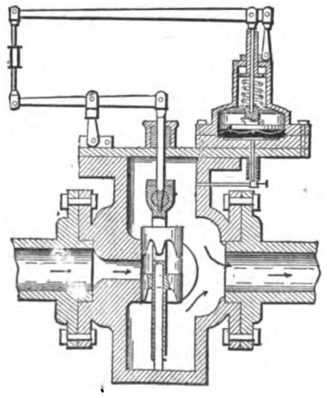


FIG. 12.—ACTON'S PRESSURE REGULATOR.

pressure of reduction, but the principal means of adjustment is in a hollow screw above the diaphragm. This appliance is quite small compared with the valve area, and is provided with a follower which travels with the diaphragm. The hollow screw mentioned above is placed upon the follower stem and is threaded to the diaphragm case, the stem playing easily through the hollow screw.

A double-seated valve with the top valve loose on the stem, is the subject illustrated by Fig. 13, which may be termed the M. & G. automatic Steam Pump Governor and Pressure Regulator. The upper valve being loose, yet close fitting upon the stem, compensates fully for expansion by means of a diaphragm in the upper valve which connects that with the stem.

The water piston is balanced by a weight and lever, as shown, and immediately above is a brass cylinder with a tight fitting piston, which is connected directly to the pump discharge which controls either by pressure in a closed tank, or by having the pipe opening placed at such a point in an open reservoir, in which case water flows into the cylinder pipe when the tank is full, and the weight of water in cylinder and tank causes the piston to descend and close the regulator valve. This valve is made by A. Metz & Co., Chicago, Ill.

A pump valve which takes little room and has no projecting levers or pendant weights, is shown by Fig. 14. This valve is principally designed for elevator, house and fire pumps, but will work anywhere that a water reducing valve is required.

A piston in the upper portion of the device is piped to the accumulator on pressure tank. The coiled spring holds the

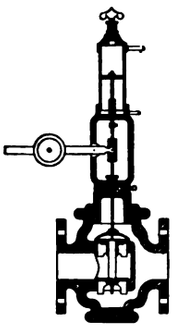


FIG. 13.—M. & G. PRESSURE REGULATOR.

valve open against the steam pressure and the nuts upon standards, shown at either side of the spring, force the latter to any desired adjustment. This valve is made by Thos. W. Ford, 130 Willoughby Ave., Brooklyn, N. Y.

An angle valve of similar action, but much different in construction, is illustrated in Fig. 15 herewith. A double-seated poppet-valve, held open by a spiral spring which is enclosed within a circular spring case, which, in turn, passes through a gland, on the outside of which is a projection which serves as a piston to restrain the valve against too sudden movements. The valve being unbalanced by pressure on an area equal to a cross-section of the valve case, the mode of operation at once becomes apparent and easily understood.

The diagram at the right represents the valve as above described, and the left-hand portion of the illustration shows an application of this valve which is of great service when concerns have their own fire pumps in connection with city pressure, or a high-pressure reservoir. The engraving shows this valve so arranged that a pump can force water directly into the fire mains, and not into the city pipes. It also excludes water from said city service unless the demand for water should be so great that the pump is unable to maintain the required pressure. In this

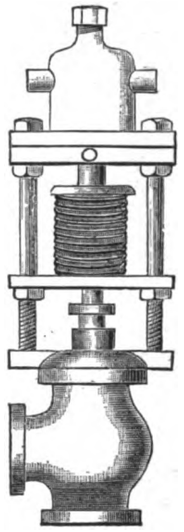


FIG. 14.—FORD REGULATOR VALVE.

case the reducing valve acts and allows city or reservoir water to flow as long as needed to make up the deficiency. The check valves shown are simply to prevent

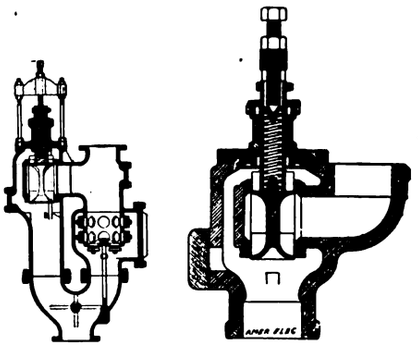


FIG. 15.—DORSMAN'S AUTOMATIC VALVE.

a flow of water in the wrong direction. This valve was invented by J. H. Douseman, 414 Matthews Building, Milwaukee, Wis.

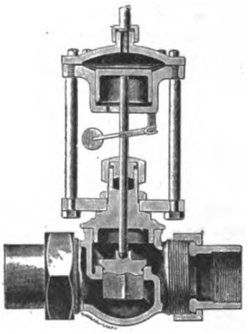


FIG. 16.—CROSBY WATER REDUCING VALVE.

A type of regulator-valve is shown by Fig. 16, whereby all the mechanism is attached directly to the bonnet of an ordinary valve. The closing mechanism is a

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weight which acts against the pressure of water. The valve-closing device is a diaphragm working down upon a follower, closing the valve directly and positively. The only frictional contact is between the small valve stem and a stuffing-box. The valve disc is entirely separate from the valve stem, which has merely a

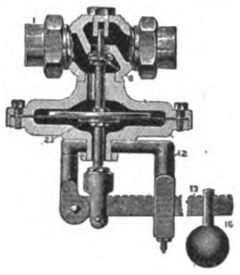


FIG. 17.—MASON VACUUM VALVE.

point bearing against it, permitting the device to act as a check valve as well as a pressure reducer.

Figs. 17 and 18 present two distinct types of "Vacuum Pressure" regulating valves. They are used chiefly for controlling steam where vacuum systems of heating are employed.

Fig. 17 is known as the Mason Vacuum Valve, and is used to maintain a vacuum of a certain number of inches of mercury. It may be kept on a certain pipe or system, while the pump is maintaining as great a vacuum as possible at all times. Little description is needed when once it is realized that this valve is to vacuum exactly what a reducing valve is to steam pressure.

The valve shown by Fig. 18 is especially used for a straight reduction of high-pressure steam to a point below the atmospheric line, a difference in area between the two valves, acting against pressure on a diaphragm. The ratio between

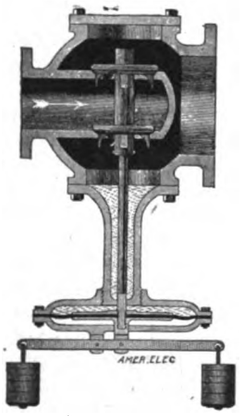


FIG. 18.—KIELEY'S VACUUM PRESSURE REGULATOR VALVE.

the two being controlled and adjusted by the double lever and weights, as shown.

These valves are also made with a graduated lever when desirable that very close regulation be secured.

A reducing valve which avoids entirely the use of all springs, levers or weights is shown by Fig. 19 herewith. The usual diaphragm is employed and the chamber in the lower part of the appliance, below the diaphragm is filled with air under pressure according to the reduced pressure of steam required. A seat is provided into which the diaphragm disc is forced when the valve is wide open, and when there is no pressure in the main pipe. This relieves the diaphragm of the strain otherwise put upon it. The air chamber is charged by means of an ordinary bicycle pump, or with a gage tube. The air pressure may be varied to obtain any required pressure in the steam main on the low pressure side of the valve.

As shown by the appliance above and below the double poppet valve, the muffler principle has been applied, making the action of the valve practically noiseless, even when passing a large volume of

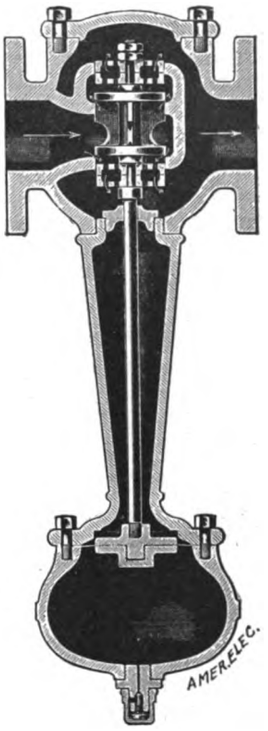



FIG. 19.—AIR-SPRING VALVE.

steam. It is the intention of the manufacturers, D'Este & Company, Boston Mass., to secure in this valve, among other things, a device whereby dry steam may be secured at all times, despite boiler fluctuations, by slightly reducing the pressure so that re-evaporation will take care of all moisture in the steam.

## THE OPERATION OF ALTERNATING CURRENT FAN MOTORS AT DIFFERENT FREQUENCIES.

BY P. M. HELDT.

It is often desirable to operate a fan motor designed for a frequency of 16,000 alternations per minute from a circuit of 7200 alternations per minute, or vice versa. In such cases the questions arise: Will the motor operate satisfactorily at the changed frequency without any changes in the winding or connections? If not, what changes have to be made to adapt the motor to the new frequency? What will be the relative current consumption at the two frequencies?

The alternating fan motors now on the market are based in their design on different principles, and these questions can only be answered by referring to a particular type. All alternating fan motors belong to either of the following types: Laminated field series motors, induction motors and synchronous motors.

The speed of the laminated field series motor is not, to any great extent, dependent upon the frequnecy at which it is operated, and motors of this type can, therefore, be run from both low and high frequency circuits. Of course, the hysteresis loss in the laminated field core is greater or less in proportion to the frequency, and for this reason a motor intended for 7200 alternations would be somewhat less efficient when run at 16,000 alternations. On the other hand, the counter e. m. f. of self induction would be greater, the higher frequency choking both the current more and reducing the power.

With the induction type of fan motors, which is that most used, the case is different. The speed of rotation is here directly proportional to the frequency, and inversely proportional to the number of poles. These motors are therefore not directly interchangeable on circuits of different frequencies; but if we can change the number of poles in the inverse ratio of the frequencies, the motor ought to still run at about its regular speed. An induction desk or bracket fan motor for 16,000 alternations usually has eight poles, and one for 7200 alternations four. Now it is plainly impossible to make an eight-pole machine out of a four-pole machine, but a four-pole motor can be made out of an eight-pole motor by connecting the field coils in such a manner that two neighboring poles are of the same polarity. A corresponding change would have to be made in the device which renders the motor self-starting. If, for instance, the motor has shading coils surrounding one-half of each pole, these have to be replaced by coils on every alternate pole surrounding the entire pole. There are now only four magnetic circuits in the field instead of eight, as before, and the magnetic density in the yoke will have to be doubled. The magnetic density in high frequency motors is usually quite low, and it would not be very difficult to double this density.

A motor thus reconstructed should give fairly good results, although it will be lower in efficiency than a motor specially constructed for this frequency, owing to the uneconomical distribution of the iron in the field core and the fact that a certain amount of electric energy when expended in one coil will produce considerably more magnetic effect than when expended in two smaller coils placed in parallel magnetically. When it is considered that the motor will be rather less efficient and that considerable work is required to make the necessary alterations it appears hardly worth the while to change a fan motor in this manner.

A synchronous fan motor will operate only on one frequency.

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# Letters on Practical Subjects

## A Puzzle.

*To the Editor of American Electrician:*

Sir—A few years ago I placed telephones connecting the house and a stable of a summer residence. For reasons then in force the Watson switch was not used. The ringer magnets were wired permanently in the main circuit, and shunted by differentially wound resistance coils, intended to have enough resistance to send a great part of the ringing current through the magnets, and to serve as a non-inductive path for speech currents, past the magnets. It worked well.

The place is occupied only during the summer. A few days ago, on reoccupying it for this season, the stable telephone was found to work unsatisfactorily. On inspection I found the resistance coil shunts burned at both stations. The house and stable are about one thousand feet apart. The "line" is lead encased wire under ground, with a No. 16 copper conductor, Okonite rubber, braided, and heavy lead covering. With the exception of a short distance near the center, the cable is four or more feet below the surface, and is nowhere exposed above the surface; at the ends it enters the cellars, low down through the foundation walls. The wires from the telephones are connected with the copper core and lead case respectively, the latter, of course, serving as a return. The system has no connection with any other wires. Where and how did lightning get on that line sufficient to burn the resistance coils, and, if differentially wound coils have no inductance, why did they burn in places instead of the whole coil being heated? The magnet wires were not burned. I enclose herewith one of the burned resistance coils for your inspection.

F.

*To the Editor of American Electrician.*

Sir—Supplementing my recent description of damage to telephonic apparatus, connected with an underground line.

A lightning storm passed over that place yesterday afternoon. A discharge struck a large stone-capped chimney on the house, breaking the cap and scattering the chimney for several feet from the top, when it apparently found sufficient conductivity to carry it down without further damage. No effect of the discharge could be found on any wire or elsewhere in the house, but the wires of the bell magnets in the stable were burned in many places, both on the surface and at the core. The stable building was not struck. The wires leading from the end of the cable in the cellar to the telephone are the only electrical wires in the building.

F.

June 6, 1899.

## The Effect of Capacity Upon Alternators.

*To the Editor of American Electrician.*

Sir—The three-phase transmission line of the San Joaquin Electric Company is operated at 19,500 volts and extends a distance of 70 miles from the power house to Hanford. Current is supplied to Hanford at the extremity and also at Fresno, midway betwen the two extremities. When the line switches are open at the power house the voltage on the generator bus bars drops several volts, and when they are in at the power house and nothing connected to the line at Fresno or Hanford, the voltage on the generator bus bars rises several volts. In other words, the voltage of the generator is higher with the open line connected than when running empty with nothing connected. Please explain the cause.

J. A. THUNEN.

North Fork, California.

The action described is due to what are called condenser currents coming out from the machine to charge the long overhead transmission line. The line is so long and the voltage so high that these currents amount to considerable and affect the machine, as described in the "American Electrician" of April, 1899, on page 179. The action of capacity on alternating current lines is peculiar. As the electromotive force of the machine rises a current flows through it to give an electro-static charge to the line whether there is any load connected or not. Thus, considering a single alternating wave of e, m. f. there is a current flowing to line as the e. m. f. rises and nothing when the e. m. f. is at its maximum point and not changing in value. Thus the current is ahead of or leading the e. m. f. and tends to have exactly the reverse effect of a lagging current, that is, at the instant when it flows in the armature conductors they are in such a position that this leading current tends to strengthen the field.

## The Machine Winding of Continuous Rings.

*To the Editor of American Electrician:*

Sir—Could you or any of your readers tell me of a machine, or how to construct one, that would wind wire on a continuous or closed iron ring core, such as a Gramme ring armature, or the regulating coils on the G. E. alternating fan motor? I should like to take the wire from a spool without winding it upon a shuttle.

W. W. N.

## A Peculiar Arc Line Trouble.

*To the Editor of American Electrician:*

Sir—We are having a great deal of trouble with our arc line. It opens and closes several times a day. If the current is put on while the circuit is closed it will stay closed, but if the dynamo is started while it is open it will not close. The plant was installed by the Fort Wayne Electric Company and the dynamo and lights are made on the Wood system. The lamps have all been taken down and tested separately, but as soon as we begin to test the line it seems to close up.

If any of your readers have had similar experience and been able to account for it I should like to hear of it.

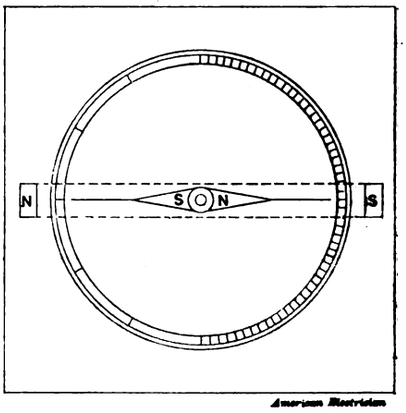
HERVEY SCOFIELD.

Mohawk, N. Y.

## The Testing of Armatures.

*To the Editor of American Electrician:*

Sir—Every electrician who has had to repair armatures knows how difficult is is to locate a broken connection or a short circuited coil by means of the ordinary magneto bell or other apparatus convenient in repair shops. The use of the Wheatstone bridge is quite impracticable as a rough and ready means of testing, since it requires such delicate adjustments. An open circuited coil frequently requires the unsoldering of the connections to the commutator bars before it can be located and a short circuited coil is difficult to find even when the coils are separated in this manner. A method which I have adopted and which is, so far as I know, original with me, is given as follows for the benefit of your readers.




Procure a good compass with a delicately poised needle, fit it in a square block of wood and fix in the block a small permanent magnet to give the needle a restoring force against deflecting tendencies. The general arrangement of the needle, scale and magnet is shown in the accompanying sketch, which requires no further explanation.

This instrument should be laid on top of the armature to be tested, or suspended above the same to save handling, with the needle parallel with the armature conductors. A source of direct current (either a battery or dynamo voltage through lamps) should then be connected to adjacent bars of the commutator. If the coil between these bars is O. K. the needle will be swung around violently; if it is short circuited there will be little or no movement, and if open circuited the needle will give a few slight swings, which show the current flows through all the coils on the armature. By using the proper strengths of current for armatures of different resistances and different numbers of turns per coil, the method is capable of considerable delicacy.

THOMAS BARNARD.

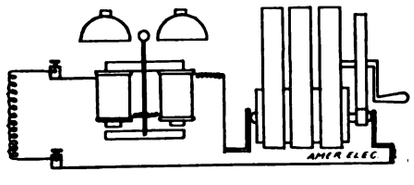
Toronto, Ontario.

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# Electrical Catechism

*314. How can a circuit be tested by a magneto?*

The magneto consists of two parts, the generator and the bell, which are electrically connected in series with one another and with the circuit to be tested as suggested in the figure. When the armature of the generator is revolved by the crank, an alternating electromotive force




BELL MAGNETO

is generated which sends current through the circuit and rings the bell if the resistance of the circuit is not too great.

*315. How can resistance be measured by a magneto?*

The loudness of the ringing of the bells indicates roughly the current flowing. If one knows the greatest resistance through which his magneto will ring, the loudness of the ringing is a rough indication of the resistance of the circuit being tested When the bell rings almost as strongly as when the magneto is short-circuited on itself, it shows that the circuit is of low resistance. When the bell rings only feebly, it shows that the resistance is high. If the bell does not ring at all, it indicates that the resistance of the circuit is higher than the range of the magneto; in such a case, however, one should test the magneto itself to see if it will ring when its own terminals are connected directly together. As the magneto is liable to give wrong indications, it must not be depended upon too much.

*316. How can the sensitiveness of the magneto be increased?*

If the resistance is so high that not enough current will pass to ring the bell, one can detect the continuity of the circuit by putting his hands in the circuit, by putting one terminal of the magneto between two fingers and touching the back of the hand to the end of the circuit, wetting the fingers and back of hand if necessary. Turning the magneto faster raises its voltage, and so makes it more sensitive.

*317. How can a magneto give wrong indications?*

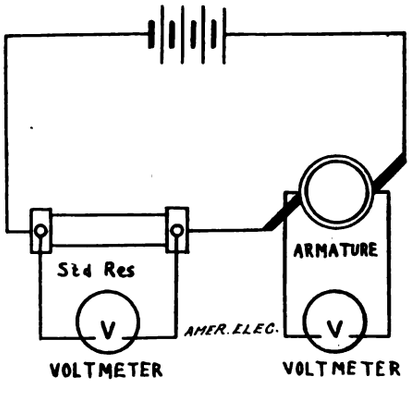
The magnets gradually get weak, so that the voltage is less, and it will therefore not ring through so high a resistance as when it was new. Again, the wires leading from it are liable to get broken, so that the bell does not ring, even if the circuit under test is continuous; for this reason, one should always test the magneto by touching its terminals together to see if it will ring on short circuit. Again, the magneto will sometimes ring when the circuit is open.

*318. How can a magneto ring when its circuit is open?*

This will occur when the circuit has large capacity, and is due to the fact that the magneto gives an alternating current. When the circuit has considerable capacity, it acts as a condenser; at each turn of the armature of the magneto, a rush of current goes out to charge the surfaces of the condenser, ringing the bell on the way; when the armature has made another half turn, the current rushes back and the condenser is charged in the opposite direction. The capacity between the frame and the windings of a large machine is enough to make some bells ring; one can feel the current through his hand even with a small dynamo, although the ohmic resistance of the insulation is up in the megohms. A few hundred feet of lamp cord has enough capacity to make some magneto bells ring.

*319. How can resistance be measured by means of a standard resistance and voltmeter?*

The circuit whose resistance is to be measured is connected in series with a standard resistance—that is, a conductor whose resistance is already known, and a steady current is sent through both. The voltmeter is connected first around one resistance and then around the other, as suggested in the figure. Since the same current flows through both con-




ductors, the voltage or fall of potential through each is proportional to its resistance, and we may write the equation: current equals voltage around standard divided by its resistance; also equals voltage around conductor being measured divided by its resistance, or

$$C = \frac{E_s}{R_s} = \frac{E_x}{R_x}.$$

From this we get: Resistance of conductor being measured equals the voltage around it multiplied by the resistance of the standard and divided by the voltage around the standard, or

$$R_x = \frac{E_x R_s}{E_s}.$$

*320. Give an example of measuring resistance by use of voltmeter and standard resistance.*

Suppose it is desired to measure the resistance of the armature of a 4 kw. dynamo. A standard resistance of 0.01 ohm is connected in series with the armature and a current of say 24 amperes is sent through both. The voltmeter shows 0.24 volt when connected around the standard. The terminals of the voltmeter are then pressed against the same commutator bars against which the brushes rest (the armature being held stationary) and the drop through the armature is measured; the armature is then turned to a new position and the voltage is again measured between the commutator bars under the brushes; this is repeated for several positions. Suppose the average is 5.0 volts. The resistance of the armature is then:

$$R_x = \frac{E_x R_s}{E_s} = \frac{5\,0 \times 0.01}{0\,24} = 0.208 \text{ ohms.}$$

*321. What precautions are necessary for accuracy in measuring resistance by standard resistance and voltmeter?*

The standard resistance must be suitable for carrying current of considerable magnitude without appreciable heating; ordinary standard resistances consist of fine wire wound closely on spools with little chance for cooling, and such can safely carry only small currents without undue rise of temperature. The "shunts" used with Weston switchboard ammeters are suitable for such use. One should be careful that the current does not change while the voltages are being measured. The voltmeter should have fairly high resistance so as not to divert an appreciable amount of current from the conductor around which it is shunted. Of course the voltmeter should give correct readings and the standard resistance should be reliable. The voltmeter should be shunted around the resistance to be measured, care being taken not to include the connections or any other resistance.

# Queries and Answers

How can I tell when a storage battery is charged to its fullest extent? J. A. E.

The measurement of the voltage is one means of telling, as the electromotive force rises and attains the value of about 2.3 volts per cell when the battery is full charged. Thus a 44 cell battery will show a pressure of about 101 volts when full charged. Another way of telling is by the "gassing." When the battery is fully charged any more current causes the evolution of bubbles, which give a continuous hissing sound, which serves as a ready indication of the condition.

We are running one dynamo, a 45-kw., to supply a maximum load of 280 amperes, station volts 130. We have two circuits (about evenly divided in load) of No. 00 wire running about 1000 feet from the station, and about ¾ of our load is within this distance, but about ¼ of the load is beyond this, scattered among the residences, the farthest being about ½ mile from the station. Within

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the 1000 feet limit we deliver current to the lamps at from 125 to 115 volts, and furnish the right voltage lamps for the different customers, but beyond that distance we furnish 110 volt lamps, and at the time of full load, during the evening, of course the distant consumers do not get their full voltage, because of the excessive drop.

Under these circumstances I wish to know if it would be practicable, and would there be any saving in power to run a 3-wire circuit to supply this load, leaving two of the 00. wires for the positive and negative, and running a No. 1 for the neutral. And in this case would it be better to run the three-wire system for the supply of all the load, or only to the 1000 feet limit and beyond that use only the two outside wires, making a 220 volt circuit for the distant load?

As it is now, we have an average drop of 10 per cent. and some of the distant lamps burning below their rated voltage part of the time, while the other way we could keep the drop within 4 or 5 per cent. At present we keep tne voltage at 130 (of machine I mean) only during the heavy load of the evening, allowing the voltage to drop as the load goes down, running at 120 volts from 11 P. M. until morning.

The only additional expense for making the change would be changing the lamps and wiring, as we have another dynamo of 25 kw., 125 volts, so practically the only thing to figure would be the expense of running another machine. F. L. W.

The 3-wire system would undoubtedly be an improvement, not that there would be any material saving in power, because the added losses of running the other machine would undoubtedly amount to more than the reduction in the losses in the line, but the regulation at the lamps would be greatly improved and an allowable increase of load on the same copper would do away with the need of re-inforcing the feeders for some time to come. The idea of feeding the distant load by a 2-wire 220-volt system and the adjacent load by a 3-wire system is a very good one, as it would do away with the need of balancing the scattered residential load, a difficult thing to do, but it might be better to run the whole load on the 3-wire system in order to make it possible to shut down one machine during the hours when it is lightly loaded. This is often done by making the neutral one side of the circuit and throwing the positive and negative or outer wires together, so that one 125-volt machine delivers current to both sides of the system, on the 2-wire 125-volt plan during hours of light load. The saves the expense of running two machines at all times. The determination of whether this advantage would be sufficient to compensate for the disadvantage of making the whole system 3-wire would depend on the cost of running during the lightly loaded hours and the magnitude and distribution of the scattered loads.

What is the best way to remove all trace of magnetism in a watch? E. C. S.

The best method is to rig up a solenoid on a wooden spool with a hole bored through of sufficient size to admit the watch into the middle of the solenoid. This should be wound to a depth of about ½ or ¾ of an inch with No. 18 or No. 20 wire, the whole coil being about 6 in. long. It should be then connected to an alternating current circuit. By slipping the watch into it at one end and out through the other while the coil is in the circuit the magnetism can be easily removed. The action is due to the rapid alternations of magnetism gradually dying down as the watch recedes from the coil. The same effect can be obtained by another method with an ordinary dynamo if great care is taken. The watch should be suspended from a long string twisted many times, so that when released it will rotate rapidly. It should then be brought close to the pole of a dynamo, twisted up tight and allowed to spin while gradually removed from the dynamo to a distance of several feet. Several trials will probably be necessary to make this method effective.

How many watts are usually allowed per average candle power on arc and incandescent lights? D. U. S.

Incandescent lights generally run about 3 or 4 watts per candle-power when new and 4 to 6 watts when they have been burned several hundred hours, owing to the fact that the candle power goes down while the power used remains practically constant, thus a 16 candle-power lamp uses from 50 to 65 watts. Special lamps of a lower efficiency are made for street railway circuits and other places where the regulation is poor. Such lamps of 16 candle-power take 75 to 80 watts each. Open arc lights are generally termed 2000 candle-power when using 10 amperes at 50 volts, although their real mean spherical candle-power is only 500. Their power consumption is thus about ¼ watt per nominal candle-power and 1 watt per actual candle-power. Enclosed arcs generally run about 1½ watts per candle-power with clear glass globes, 2 or 3 watts with opalescent globes and more if both inner and outer globes are not of clear glass.

How far will telephones work through submarine cables? Will a metallic circuit increase the range, or give better satisfaction than a return through earth? If relays or repeaters could be used, how many would be required to work a cable across the Atlantic Ocean? J. A. H.

About 50 or 60 miles is the present range of clear transmission through submarine cables of ordinary construction. A metallic circuit greatly increases the range, in fact, the limit with a ground return is much less than the figure given above. If a perfect repeater were available it would require about 40 of them, spaced 50 miles apart, to reach from Newfoundland to Ireland.

Is there any prospect of improving the efficiency of a cable and any room for improving submarine telephony and telegraphy? Do any of the cable companies experiment with a view of improving the speed of transmission? J. J. P.

The greatest chance for improving both submarine telegraphy and telephony is the development of some system of distributed self-induction and possibly also slight distributed leakage by means of which the waves of current will be maintained at more nearly full strength as they pass through the cable, instead of being absorbed by the capacity. The cable companies experiment with apparatus after it has been proven on artificial cables that it may improve the working.

Are there any patents covering the induction motor? Please refer me to some book on monocyclic distribution and the induction motor. J. H. W.

The patents issued to Nikola Tesla and now owned by the Westinghouse Company cover broadly the use of polyphase currents in induction motors. Single-phase induction motors are not broadly patented, although various devices for starting them and details of construction are covered by patents. Houston & Kennelly's "Alternating Electric Currents," price $1, explains the principles you desire.

Do you know of any electric plant at present in existence whose line voltage is as high as 30,000 volts? If there is, must not unusual precautions be taken with the insulation? S. D. W.

The Southern California Power Company uses 33,000 volts on its line, 81 miles in length, supplying power to Los Angeles. No special precautions are taken with the insulators on the line, which is exposed to bad fogs and heavy rains. This is the highest voltage used commercially. The Westinghouse Company has experimented with 40,000 volts at Telluride, Colorado. At this pressure brush discharges, like those of a static machine, stream between the lines and waste quite a little energy.

How is the selenium cell made which Prof. Bell used in his instruments for transmitting speech by means of a beam of light? G. H. G.

The statement in one of our contemporaries that a selenium cell was used was in error. The receiver consisted of a delicate carbonized fibre like that of an incandescent lamp, only finer. The light was focussed upon this and the variation of its temperature changed its length, which motion was transmitted to a diaphragm. The transmitter consisted of an ordinary solid back carbon grain microphone in a special fire-proof case, connected in series with a resistance and in shunt with the arc. As the resistance of the microphone varied it took more or less current from the arc, varying the rays of heat sent out from the latter, which in turn affected the fibre at the receiving station.

How can I tap the windings to the collector rings in a Crocker-Wheeler machine for direct and alternaitng currents? W. H. S.

The collector rings can be put on the other end of the armature from the commutator. If single-phase alternating currents are wanted use two collector rings. Tap one into any coil and notice which commutator segments that coil is connected to. Tap the other collector ring into the coil connected to the commutator segments diametrically opposite those connected to the first ring. If two-phase currents are wanted add two more collector rings and connect them with coils connected to segments at right angles to those already used. If three-phase currents are wanted, use three collector rings and connect them respectively to coils connected to commutator segments 120 deg. apart upon the machine.

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## A WATT-HOUR METER HAVING "MAGNETIC FLOTATION" INSTEAD OF MECHANICAL BEARINGS.

After several years of patient, painstaking investigation, study and experiment, to produce a recording watt-hour meter which should meet all the trying conditions and requirements of central station distribution, Mr. William Stanley succeeded in solving a perplexing problem.

It was intended to produce a measuring and recording device so simple as to be easily installed and cared for by any wireman without special training, durable and sufficiently strong to withstand the inevitable rough usage in transportation and handling and injury liable from short-circuits or overloads, and, withal, one which should possess a degree of accuracy and range comparing favorably with the finest scientific instruments designed for laboratory use.

It is the purpose of this article to review some of the difficulties which have been met and overcome in making a watt-hour meter combining the sensitive accuracy of such instruments with the permanency and adaptability essential in a good commercial meter, one which must be correct for all ordinary and variable conditions of any installation supplied by a central station. These conditions are difference in size of installations, in current loads, in voltages, in power factors, and sometimes in current frequency. Personal education of the wireman and inspector must be eliminated, the meter manufacturer supplying in each of his instruments an enduring standard to properly place the line of equity between the producer and consumer.

Regarded in a purely scientific light, such an instrument must undergo many and varied trials. If it is to be for general use, its capacity should be of at least five to ten kilowatts, but its service must be rendered frequently upon a demand of only fifty or twenty-five watts. It must be capable of rough treatment and remain uninjured and unaffected by it, either before or after its wooden shipping box has been removed. It must be received ready for commission without adjustment or calibration, be inaccessible to the curiously inclined, and being hermetically sealed, proof against dust, rust, moisture or any foreign substance, and finally, always ready to freely and correctly record the energy consumed by one or one hundred incandescent lamps as circumstances may require. And its duty must be performed regardless of careless setting up, unsteady supports, vibration, shock, short circuits or other hardships.

In the first meter produced by Mr. Stanley a strong driving mechanism was used and much mechanical skill was expended in perfecting the workmanship and the mechanical qualities of his product. The result appeared promising. An instrument was produced that would record current through wide fluctuations of load, that would run freely and accurately on a single lamp, and it possessed other good qualities with which engineers are familiar. This was literally too true to satisfy the desire, because together with its virtues it was likely to change through wear from continued use. It was liable to injury by careless handling. It required care and attention in setting it up, to place it level on a solid support, to release the weight of the armature, and to adjust the jewels and other mechanism. It was dependent for its good performance upon intelligent handling by a "meter man," and, worst of all, required to approximate accurate performance, annual or semi-annual cleaning and inspection.

Upon examining the situation critically it appeared that the fundamental frailty of this meter was in the main bearing or support of the driving mechanism, and the advance was to be made in perfecting this part. A careful study of the conditions of induction (alternating current) watt-hour meters revealed the fact that they were highly accurate, provided a perfect, frictionless bearing could be devised; but in the nature of their construction, vibration was particularly severe on the best constructed bearings available. An alternating current flux, such as all induction watt-hour meters employ, causes a slight vibration or trembling of the driven part or armature of the meter, and experience soon proved that this slight trembling, caused chiefly by the shunt, which, in watt-meters, is constantly in circuit, caused a rubbing or wearing between the armature staff and its supporting bearing, and that this rubbing, constantly applied at the rate of 7200 or 16,000 thrusts per minute (according to the frequency of the current employed), rapidly destroyed any bearing that has been devised.

Mr. Stanley's next experiment was to make the armature or driving mechanism so light that the weight to be supported by the bearing could not injure a polished, blunt, hardened steel staff on a good sapphire stone. The argument that a meter disc as light as a feather could not injure the bearing was very fascinating, and following this line some beautiful models were produced with hollow, seamless aluminum staffs, the walls of which were only three or four one-thousandths of an inch thick, and pivots in the ends of this staff were made of short pieces of steel as small as an ordinary needle and less than a quarter of an inch long. The practical results were disappointing, for destruction of the jeweled bearings and staffs was caused by the continued trembling thrusts recurring at the same rate as the alternating current frequency and similarly to the wearing away of stones by dropping water, or the constant treading of feet. And in the end an accidental short-circuit demolished a handsome and expensive model by sending the meter disk out of the case upon the floor.

The next line of experiment devised was to support the moving element of the meter upon a hollow ball, floated in a light liquid or oil contained in a vessel made after the plan of the "non-spillable" ink bottles. This oil supported the armature, while it was held vertical and central by small sapphire guide rings surrounding the staff. This apparatus soon took its place with its predecessors on the model shelf, but it served the useful purpose of illustrating the extreme delicacy that is essential in a good and enduring meter bearing.

The next model, of which there were several forms, for a time promised better results. It finally took the shape of a very light, accurately made aluminum cylinder, open at the bottom and closed at the top by a flat wooden head made of three layers of wood glued together and having a total thickness of less than three one-hundredths of an inch. The cylinder was then mounted vertically upon a staff passing through the wood, which was to serve two purposes: First, to make a support by which the cylinder could be mounted and balanced in a vertical position, the passage through which support of no upward strain of magnetic lines could cause vibration; second, the wood in a small circular disc when spun around by the aluminum was designed to serve as a deadener of vibration in the latter and to prevent the transmission to the pivot and supporting sapphire jewels of any destructive rubbing produced by alternating magnetic impulses. Furthermore, the entire alternating magnetic cores for the shunt and series circuits of the meter were placed by an ingenious construction entirely within the aluminum cylinder, and so arranged that every thrust due to induction was balanced by equal thrusts on the opposite side of the cylinder, so that a completed driving armature consisted of an aluminum cylinder supported by a wooden head and driven entirely by induction from the inside, and equally applied in opposite directions. A perfect armature constructed after this plan, with ample mechanical strength, weighed, including the supporting staff and driving pinion, less than ¾ of an ounce. It seemed that this model achieved the limit of perfection in mechanical construction, strength and electrical balance, but, like its predecessors, it failed under critical tests of continued service. These were the best results accomplised at the end of very nearly two years of very close and careful work, the thoroughness and extent of which are scarcely hinted at in the foregoing.

The conclusion expressed by the experimenter was certainly discouraging, namely, that in his judgment no mechanical bearing could be found which would withstand the wear and rubbing caused by the slight, and, under some conditions, almost imperceptible vibration by the alternating fluxes in the armature of an induction watt-meter. That, while various devices could be employed to prolong the life of induction meter bearing, a real endurable bearing cannot, or at least has not, been produced. And it was when forced to this conclusion that Mr. Stanley produced a meter without a meter-

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bearing, and having no friction (except a very slight dial-train friction), and, therefore, no wear. This result he has accomplished by "magnetic flotation," and its practical application is embodied in a watt-hour meter here illustrated. Fig. 1 is an outside view of the instrument, showing the meter in its substantial air-tight case, the cover of which is secured by four heavy case-screws, which are covered with seals, at the corners.

Fig. 2 illustrates the interior of the assembled meter, the plan of "magnetic flotation" and permanent magnet brakes.

The flat aluminum disc or armature is mounted in a careful mechanical balance on a soft steel core. This core is held central in recesses in the iron pole pieces by polished, hardened steel staffs passing through phosphor-bronze guide rings. The pole-pieces themselves are magnetized by the permanent tungsten steel magnets of such polarity that the upper pole-piece and the inverted flat-head screws set therein are of opposite polarity to the bottom pole-piece and similar screws which are below the disc.

The magnetism established by the permanent magnets is made to serve a double function. It lifts and supports the soft iron core and the aluminum disc thereon mounted, to a definite position between the pole-pieces free from mechanical support, and also supplies the necessary flux threading the disc between the brake-screws to serve as a magnetic brake controlling the speed of the disc.

The series and shunt-coil windings are entirely enclosed within the meter case and separated from the permanent magnets and the magnetic flotation parts by a magnetic shield with a narrow slot through which the disc revolves. This device prevents any weakening of the permanent magnets by excessive currents in the meter. The series coils are of especially durable construction and consist simply of a few turns of heavy flat copper strip wound up with a thin strip of asbestos paper between the turns, so that there is no cotton or other combustible insulation upon them to be injured by excessive current.

As every detail of design and construction has been carefully worked out, and only the best attainable results are embodied in the Stanley watt-hour meter, attention is directed to the peculiar shape of the two permanent magnets. Iron bent after rolling has a tendency to unbend, and its shape is gradually changed. As the distance between the poles of the magnets must remain constant to secure proper "damping" or brake effect upon the disc, to obtain the best results it is essential that their ends be rigidly secured, and change of the air-gap, due to expansion or contraction, prevented. In the magnets and supports here illustrated this has been accomplished in an admirable way. Annealed, cast-iron pole-pieces are carefully made with planed faces into which the magnets are fitted and rigidly fastened by heavy screws. The pole-pieces are in turn securely screwed to a brass bracket, and the whole supported firmly upon the iron bracket. This effectually prevents any movement of the magnet poles which, remaining in a fixed position relative to the disc, exert a constant and uniform effect upon it, and thus eliminate the error so often caused by permanent magnet brakes changing by reason of a change in the air-gaps of the magnets.

The performance of the meter is quite as interesting as its construction, and with 25 watts current on a 5 kilowatt meter, the error of registration is less than 2 seconds in 120. Furthermore, the speed of the meter on 25 watts or 5000 watts would be the same whether the meter were properly connected to run forward, or improperly, to run backward; and the rate of every meter before leaving the factory is tested at backward rotation under a load of one per cent. of its capacity to determine the backward and forward rate under these conditions. Consequently the meters must be free from friction and in mechanical and electrical equilibrium, making it impossible for the meter to run or "creep" on the shunt current when there is no load on the meter.

The meter demonstrates the feasibility of constructing a large-size instrument that will run freely on one-half of one per cent. of the current which it is designed to measure, and which will record accurately one per cent. of its rated load, and will do so without compounding the meter or providing an initial starting tendency, as is sometimes done, with the unsatisfactory result of frequent "creeping" on the shunt current, especially in locations where there is any vibration.

It has been shown by what means the Stanley watt-hour meter is constructed to accomplish the purpose of a meter that cannot change by wear, that can be installed by an ordinary wireman, that cannot be tampered with without breaking conspicuous seals, that will stand much rough usage, both mechanical and electrical, without injury, and, withal, records the current passing through it with a degree of accuracy and extent of range hardly equalled by the most delicate scientific laboratory apparatus. The success of the engineering design is best appreciated when the fact is considered that these meters are not made in smaller sizes than 50 amperes (or 100-light) capacity, and yet they are sold under a guarantee of a long period to record correctly on 25 watts current or a single 8 c. p. lamp.

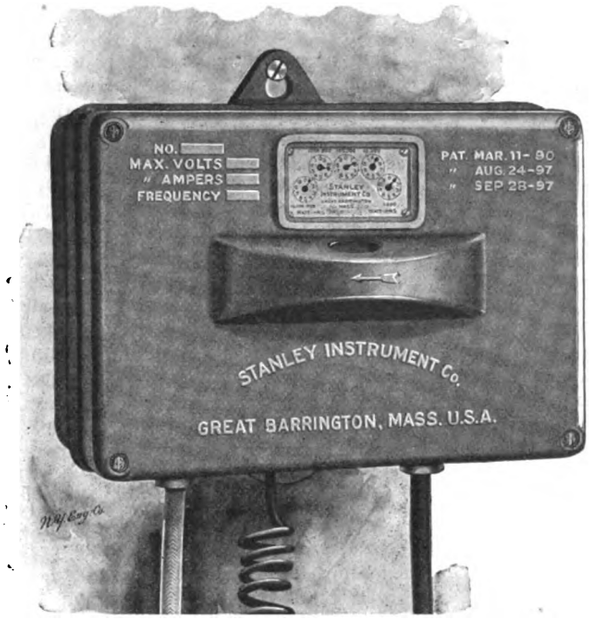



FIG. 1.

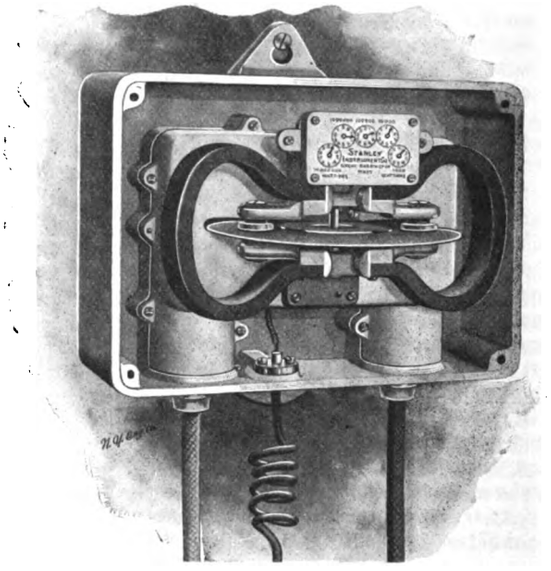


FIG. 2.

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## THE CONSTRUCTION AND PERFORMANCE OF MILL MOTORS.

The distinguishing features of the machines described below are their exceptional operating characteristics, protective forms and controlling mechanism, which fit them particularly for all work requiring either great momentary turning power, safety from external injury or convenient automatic starting and stopping. Dynamos and motors were made, at first, in the ordinary or open forms and of very high speeds. Afterward, others of medium speeds, and of very slow speeds for direct connection were produced, and now motors of still other types, having the characteristics described above, are demanded. To meet this demand the line of machines here described has been put on the market by the Crocker-Wheeler Company, Ampere, N. J.

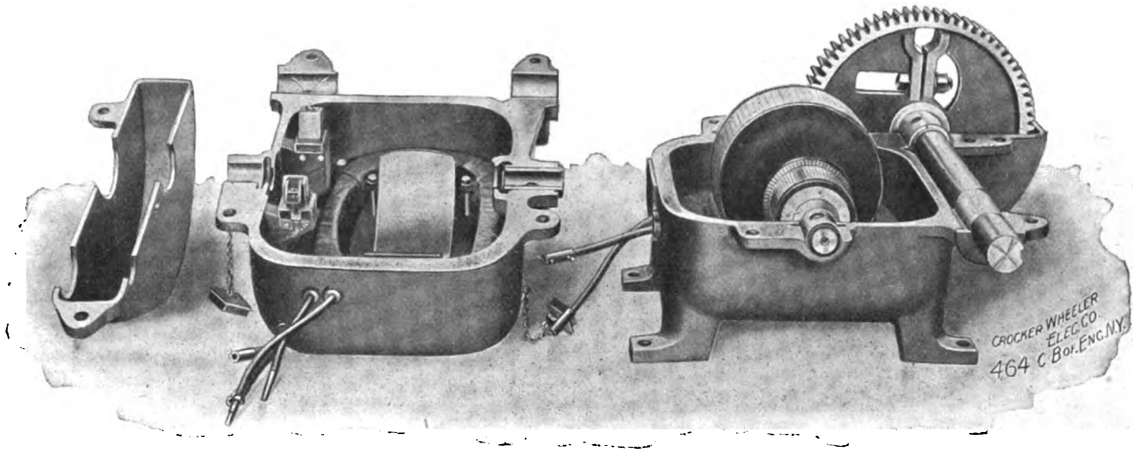



FIG. 1.—MILL MOTOR DISASSEMBLED.

Mill motors consist of iron-clad armatures, encased in cast steel boxes nearly the shape of round-edged cubes, which form the field frames.

This construction, however, prevents ventilation, and precludes their use for continuous running at full load on account of their heating up. Mill motors with back gearing are practically the same as railway or car motors, which they closely resemble. By omitting the feet, and by extending both ends of the countershaft so that wheels can be mounted on them, small car motors are made suitable for industrial railways.

The armature cores are slotted. The slots have parallel sides with rounded bottoms; the openings at the top between the teeth are the full width of the slots in order that the coils may be slipped into them from above. They are narrow and the length of the air gap is so proportioned that eddy curents in the pole pieces are avoided. The cores are built up of soft sheet iron, the laminae being insulated from each other by a layer of oxide, formed during the annealing process, and by a sheet of paper after every fourth disc. The armature being of small diameter, the discs are each made in one piece with a hole in the center to fit closely the shaft and its key. The core and commutator are mounted directly on the shaft without the intervention of a spider.

The envelopment (winding) is of the "drum" form and is connected for "two circuits." The coils, consisting of insulated wire, are wound separately on forms and dipped in insulating varnish. They are then encased in two layers of cambric. The portion of the coil which is to lie in the slots is wrapped in four layers of oiled muslin and two of rubber tape. The slots are prepared by lining with two thicknesses of oiled muslin and two of press-board, and the coils are slipped into them. After connections are made to the commutator, canvas heads are put on the front and back of the armature, affording additional protection. The field coils also are wound separately on forms, and "mummified" wth numerous layers of cambric, oiled muslin, rubber tape and paint. They are then placed in position on the salient pole pieces and held there by metal clamps, no field spools being used. This construction makes the windings practically impervious to moisture and dust and, therefore, adapted for use under the most trying conditions wthout risk of injury.

The frames have inwardly projecting poles and are divided horizontally through the axis of the armature into two parts, as illustrated by Fig. 1. The sizes 22 and 6, which have four poles, have those at the sides split by this division, and, therefore, these poles are not provided with coils, but are made consequent, the fields being energized by the coils which suround the other poles, that are above and below the armature. The bearings are rigid instead of self-aligning, this form being stronger for heavy work. The journal boxes are divided horizontally, the lower halves being seated in projections of the frame. A heavy grease which will run through a small hole when warmed by friction, is contained in a grease cup over each bearing.

Relation of Speed and Torque.—In their operation, mill motors differ essentially from belt type machines, in these particulars: When slowed down or started from a state of rest, they are capable of exerting a turning power many times greater than that given at full speed.

Like a horse, they slow down and redouble their effort when required to move a heavy load, while belt type (shunt wound) motors do their work at full speed and in a manner similar to that of a well governed steam engine, whose best work is at full speed and which is incapable of increased effort at reduced speed.

The efficiency of mill motors is a little lower than that of belt type machines, because they are designed to have certain other characteristics in a marked degree by its sacrifice. That obtained at starting and at low speeds is small, because the losses are nearly as great as at any time, while comparatively little power is developed, although the machine makes a great starting effort. At middle speeds, the efficiency is the highest, because the product of torque and speed, which is the output, is at a maximum. It is lower again at high speeds, as the torque is reduced so much by the light loading and the effect of the series winding, that although the speed is very high, their product, or the output, is less than before.

These characteristics of speed, torque and efficiency may be examined in detail in the curve, Fig. 2, from which the actual values may be read, as the curves were plotted from tests of machines.

The heating standard is 55° C. rise above the temperature of the surrounding air after one hour's continuous run, or 10° higher than that adopted for open motors, whose ventilation is good. In enclosed motors there is no ventilation, but this rise in temperature is not dangerous to the insulation. It has the recommendation of the Standardizing Committee of the American Institute of Electrical Engineers.

Heating Time Average.—As has been pointed out mill motors, being enclosed, are liable to excessive heating if run continuously at full load. Being designed, however, for intermittent work only, this is unimportant, and the limit is seldom reached on account of the character of the work for which they are employed, which allows intervals for cooling. In consequence of this the temperature rises only

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to correspond with the amount of time the motors are used under load. Therefore, the determination of the "time average in heating" is important. If the machine retained all its heat when the current was applied—losing none—it would heat up rapidly at a uniform rate, as indicated by the dotted straight line, Fig. 3, reaching the maximum alowed for safety in a very short time. A hot machine when allowed

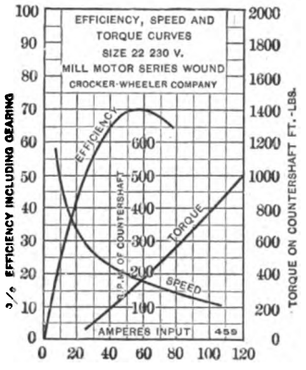



FIG. 2.

to cool, cools rapidly at first and more slowly afterward as its temperature reduces; because, then, there is less difference between its temperature and that of the surrounding air to induce the transfer of heat from it to the air. Its rate of cooling is, then, rapid at first, and slower afterward, finally extending over a number of hours as the temperature reaches almost that of the air, as indicated by the dotted line which slants downward to the right in the diagram, and by the other shading lines which are duplicates of it and represent the same rate of cooling started at different periods of time.

These curves cover the principles involved in the determination of the temperature which a machine will reach under any conditions of use. Applying them to a machine intermittently under a full load, we see that when it is started it will heat up in accordance with the solid curve for as long a time as it is used, and will, when stopped, commence to cool off from that temperature, following the shading line of the diagram representing the rate of cooling off. When started again it will resume heating up from this new point, and heat up again as long as in use, following a section of the corresponding curve of heating, and when stopped will again cool off in manner corresponding to the curve of cooling, and so on. In the diagram the machine is represented alternately in use ten minutes and idle twenty minutes. It will be seen that when the machine's temperature is low, the heating with use is rapid and the cooling off slight. As the machine becomes hotter, say after the second hour's use, the heating amounts to less and the cooling off to more. The machine will finally reach a temperature as high as will be necessary to cause it to cool off in twenty minutes as much as it heats in ten, but lower than its maximum temperature for continuous use.

If the conditions of a machine's load are known in advance, the proper size to install can readily be determined by means of these curves. For instance, if it is to be used only five minutes every half hour, a smaller machine may be used than if its work keeps it running ten minutes out of every fifteen.

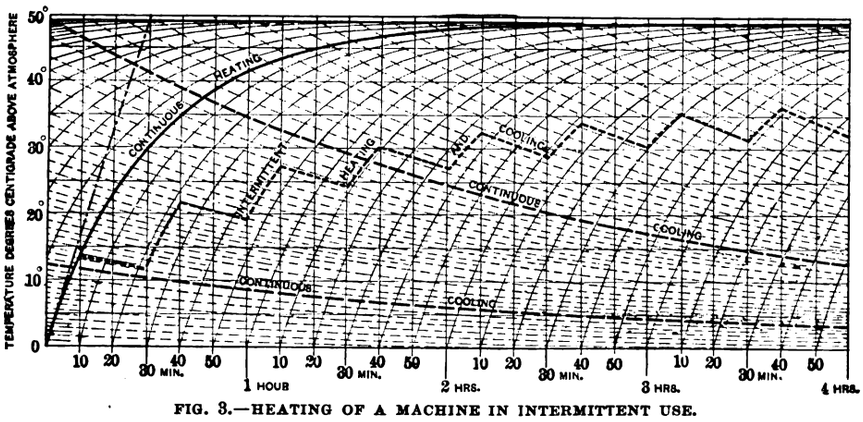



FIG. 3.—HEATING OF A MACHINE IN INTERMITTENT USE.

## THE INSURANCE OF ELECTRICAL MACHINERY.

The general principle of insurance is designed to protect property owners against sudden and unexpected losses, generally of a magnitude too great for them to meet, the risk of such losses being taken by comparatively wealthy organizations, known as the insurance companies, who depend upon a system of averages for their compensation. Another condition of proprietorship on which insurance is desirable is the ownership of machinery or apparatus which the owner does not understand and in the care and maintenance of which he is therefore more or less helpless. He can, to be sure, engage employees who are presumably competent to attend to the apparatus, but owing to his own lack of knowledge upon the subject this presumption may be and often is a mistaken one. The employee is, at the best, not entirely responsible for the apparatus under his care and may shift the responsibility, in case trouble comes through his incompetency. In case repairs or renewals are needed the owner is more or less at the mercy of those who must undertake the work, owing to his lack of exact knowledge as to what is needed. On this acount the existence of a company which would step in and assure the maintenance of his machinery in proper running condition for a given sum, would prove to many an owner of such machinery a great boon. Such a company is The Maintenance Company, of 220 Broadway, New York City.

This company enters into a contract with its patrons, guaranteeing them for one year against any losses on account of failure of or accident to their electrical machinery, exclusive of wiring. The scope of the insurance is about to be extended to cover gas, steam and other machinery. Differing from other companies which have engaged in similar lines of business in the past, The Maintenance Company does not operate a repair shop, but renews, at its own expense, all parts when required with duplicates from the original manufacturer; patch work is thus avoided, the machine is maintained in practically as good shape as new, patent rights on details of construction are not infringed, and the good-will of the manufacturers is retained as they lose no business, in addition to which they feel no risk of their machines being repaired by unskilled men.

Naturally The Maintenance Company, after issuing such a guarantee, takes care that the apparatus is kept and attended in such a way as to avoid failures and break downs, the expense of which the company must assume. The company therefore has a corps of expert inspectors who have at their disposal the best of instruments for the making of tests and who are directed to regularly inspect the machinery and see that it is in the care of competent men. The inspectors also act as instructors to the engineers and help them in case of trouble which they do not understand.

The company was organized with a capital stock of $100,000, which is fully paid in, part of which is deposited with the Colonial Trust Company as a trust fund against which each contract is a claim. This trust fund is maintained at about 75 per cent. of the total premiums written. A large part of the company's business is obtained from manufacturers themselves, who, instead of guaranteeing their machines for one year, turn over this feature to The Maintenance Company, the guarantee to the latter being, of course, of greater benefit to the user of the machinery than is the manufacturer's guarantee, as the latter is, as a rule, solely applicable in case any trouble which occurs can be proven to be due to an original defect, while the guarantee of The Maintenance Company is against all trouble. As the guarantee for the first year is, as a rule, extended by the user of the machinery, the company can well afford to make attractive rates to the manufacturers to induce them to turn over this troublesome feature of their business. The company now has something over 1000 machines under contract, largely in isolated plants.

The officers of the company are as follows: Jas. J. McKenna, President; Joseph M. Cooper, Secretary, and Ernest R. Bartlett, Treasurer.

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## AN ELECTRIC SUPPLY HOUSE AND THE WAY IN WHICH IT IS CONDUCTED.



ONE of the largest of the supply or jobbing houses that have come into existence to meet the demand for the many appliances used in electrical engineering is the Electrical Appliance Company of Chicago. In this connection should be noted the difference between the meaning of the words "appliance" and "machine." The former applies to a part of a machine or an accessory that assists the machine to render its service, while the latter word is the name of a device that orginates its own action or produces something. Using this distinction it may be noted that this house deals chiefly in appliances, unless an electric fan can be called a machine.

The building shown in the initial letter, to which the business of this company has recently been moved, is a five-story brick structure with basement, located on the corner of West Van Buren and Jefferson Sts., and has a ground dimension of 50x100 feet, giving about 30,000 square feet of floor surface. The stock includes everything listed in a general catalogue of electrical appliances, embracing those for street railways, electric lighting plants, telephone outfits and telegraph sundries. In the telephone department the company manufactures its own telephones, the type being a distinct or standard make. One of the distinguishing features of this telephone is the design of the transmitter, which is moisture-proof, and is constructed with a diaphragm of either carbon or metal, while the granules are chemically treated, producing a sensitiveness not generally found in telephones.

The first floor of the building is occupied by the offices of the managers, offices for the clerical force and at one corner is the retail department, which carries a large assortment of shelf goods. The rooms are provided with labor-saving appliances to facilitate the dispatch of business, among which may be noted a half dozen or more graphophones, to which the chiefs and others dictate all the correspondence, which is afterward written out by a corps of typewriters.

The rear portion of the first floor is utilized as a shipping department, from which an electric freight elevator connects with the basement and upper floors; while there is a small dummy elevator for transmitting orders, and, when necessary, the smaller items of stock. Included in this department is also a telephone exchange, with an attendant having wires connecting with each room of the building and two trunk lines to central. Besides this there is an interior telephone system connecting the different departments.

The basement is occupied by heavy material, including galvanized wire, a stock of interior conduits, including both the wood lined and loricated, together with crossarms and linemen's heavy tools. On the ground floor brackets, light constructing tools, including reels and stretchers, are stored in suitable bins and racks. On one side is a large platform for carrying the rolls of covered wire and here is also carried a stock of lamps in original packages and also the fan motors.

The third floor is similarly equipped and filled with magnet wire, porcelain and clay insulating goods and other wiring sundries, while at one end of the same floor is a telephone assembling shop, which is equipped with a number of metal working tools, operated by an electric motor.

A portion of the second floor is occupied by a stock of lamp sockets, switches and cut-outs, and at the rear of this floor is the packing department. This is provided with packing counters and bins, which are numbered and lettered. One of these divisions or bins is devoted to each order and all the items of that order are assembled in it for packing.

This company was organized and began business in 1891 on the first floor of a building at 242 Madison Street. In the following year it occupied the basement in addition to the ground floor, and the third year after beginning business the entire building of three stories was required, aggregating 3,000 square feet. This being outgrown last spring, the business was moved to the present quarters, having a floor capacity three times as great as the former building.

The affairs of the company are under the direction of Mr. W. W. Low, Pres.; Thos. I. Stacey, Sec. and Treas., both of whom give their entire time to the supervision of the extensive business. They employ a number of local and traveling agents and have resident agents in St. Paul and New Orleans, so that their custom comes from all parts of the country, as well as Mexico and South American countries.



FIG. 1.—MAIN FLOOR AND RETAIL DEPARTMENT.



FIG. 5.—MACHINE SHOP—TELEPHONE DEPARTMENT.

## THE ANNUAL REPORT OF THE ELECTRIC STORAGE BATTERY COMPANY.

The enormous increase of the business of the Electric Storage Battery Company is shown in the annual report of President Rice, recently issued. The sales during the year 1898 amounted to $1,340,968, as against $1,026,926 for the preceding year. For the first five months of 1899 the sales amounted to $1,360,561, as against $314,499 for the same period in 1898.

The treasury resources of the company, after providing for all bonded and floating indebtedness, are given as $10,218,374. The report states that the company owns 5/12 of the automobile business formerly controlled by the Electric Vehicle Company and the Columbia Automobile Company, which have consolidated under the name of the Columbia and Electric Vehicle Company. The Electric Storage Battery Company is also closely associated with the Illinois Electric Vehicle Transportation Company, which has bought the Siemens & Halske electric plant in Chicago. This plant will be devoted to the manufacture of electric vehicles.

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## A MODERN PLANT FOR THE MANUFACTURE OF DYNAMOS AND MOTORS.

An example of the advance which is being made in the large manufacturing establishments of to-day is the new manufacturing plant of the Bullock Electric Manufacturing Company of Cincinnati, Ohio. This model plant was completed last summer and the Bullock Company moved in the first of the year. The buildings are located at East Norwood, Ohio, one of the suburbs of Cincinnati and less than five miles from the heart of the city. The B. & O. S. W. Railroad crosses the Pennsylvania Lines at this point and both roads have tracks entering the works giving the company exceptional freight facilities.

The several buildings are constructed of light yellow pressed brick with appropriate trimmings of stone, and are massively well built; they are separated from each other by grass plots, flowers and shrubs. Great windows are a feature of every building, and such a thing as dim light is entirely lacking in office, machine shops and power house.

The plant comprises the administration building, machine shops, foundry and power house. In the first mentioned are the general offices, drafting and pattern rooms, lunch room for officers and heads of departments, with a completely equipped kitchen and pantry, general lavatory and locker rooms for workmen and a well appointed stable. In the main hall of the administration building is an office of the Postal Telegraph and Cable Company, with an operator in charge, and a miniature telephone exchange with lines extending to the various departments. The drafting and pattern rooms are on the second floor of the building and are very light and commodious for the large forces employed. Kitchen and lunch room are home-like in equipment and decoration, and the stable in the rear is above criticism.

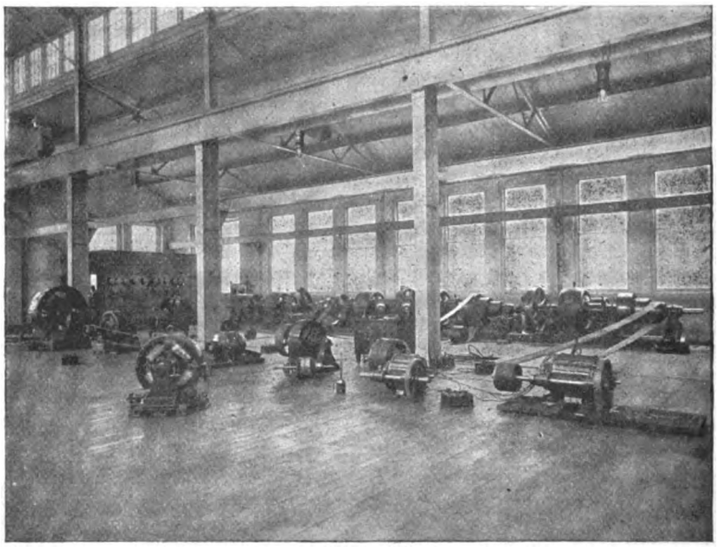


THE MACHINE SHOP.

The Bullock shops illustrate the great economic progress made in manufacturing methods during the century, or, more properly speaking, during the past quarter century. Long lines of shafting and counter-shafting; cumbersome, unsightly and light-forbidding belting, noisy, dirty and costly, all characteristic of a method of applying power soon to be, if not already, obsolete, are missing; and one is deeply impressed with the improving difference as a result of the application of independent electric motors for power purposes. Each machine in the Bullock shop has its own motor, which furnishes power when, and only when it is required.

The motors used for driving the various tools are especially designed and adapted for the tools driven, being built—in the case of the lathes—directly in the head stock, and in other tools taking the place of the driving pulley and requiring no more room. The motors are of the slow-speed type with the variable speed control governed by the multiple voltage system, which enables them to operate their tools in six varying speeds in either direction without the use of back gearing or any resistance whatsoever in the electrical circuits.

The main machine shop, all on one floor like every other building of the plant, is divided into the following departments:



THE TESTING DEPARTMENT.

The winding room, where the armatures and fields of the machines are wound and insulated; the coils of the armatures being machine formed before being placed in the slots of the armatures; the testing room, where the finished machine is tested to its fullest capacity during an entire day's run, to ascertain whether it fulfills the standard called for in the company's apparatus; the erecting shop, the machine tool shop, the commutator and brass finishing shop, where the commutators are put together, and where the brush holders, bushings and terminals are completed; the tool room, the punch department, where the armature discs are punched out of sheet metal and properly notched and the pole pieces punched and put together, and the stock room.

Last of the buildings to be described is the power house. The boiler room contains vertical water-tube boilers fitted with furnaces having moving chain grates; consequently the tall chimney of the plant is smokeless. The engine room contains a cross-compound engine direct connected to two of the Bullock Company's engine type generators, which supply current not only for the lighting system but for the multiple voltage power transmission used throughout the entire plant. A section occupying the whole southerly end of the building is set apart and fitted out for the employees' lunch room.

The officers of the Bullock Electric Manufacturing Company are: George Bullock, President and Treasurer; J. S. Neave, Vice President, and James Bullock, Secretary.

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# New Apparatus and Appliances

### A SHUNTED FUSE SWITCH.

Those who have experienced or are experiencing difficulty in opening high tension circuits will be interested in a description of the new shunted switch, which is being placed upon the market by the D. & W. Fuse Company, Providence,

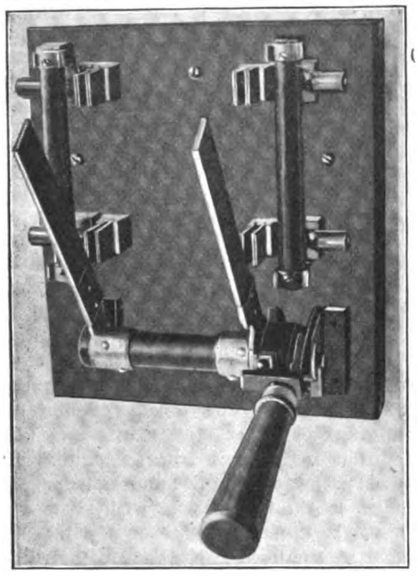


FIG. 1.—A NON-ARCING SWITCH FOR HIGH TENSIONS.

R. I., as by this device circuits of almost any potential may be successfully opened without the burning of the switch blades or any objectionable discharge.

The principle of this device, as the name implies, is the simple shunting of the blades of a novel quick make and quick break switch by one or more of the well-known non-arcing D. & W. fuses of small capacity.

By this means the actual opening of the circuit does not occur at the instant the switch blades leave the jaws, the current being shunted through the fuse, which operates an instant later than the blades, the actual opening the circuit taking place within the fuse.

The blown fuse is then removed by simply drawing it out from the spring clips, the new one not being inserted until after the switch has been thrown in circuit again, or it may be inserted just prior to the time when it is necessary to open the circuit.

Although, of course, every time the switch is opened a fuse is blown, these fuses are designed so as to be readily reloaded at a very small cost, there being no necessity for the use of solder, the company supplying the material for the refilling, which may be done by the regular station attendant.

Fig. 1 shows a 50-ampere double pole 2500-volt switch of this type. These switches have been repeatedly tested on high potential inductive circuits, having heavy lagging currents, where they have operated, it is claimed, with the most perfect satisfaction in every instance, it being impossible to detect any flash or flame at the instant of opening, the fuse operating quietly and without disturbance.

### AN AUTOMATIC REGISTER OF TELEPHONE CALLS.

The message rate system now generally adopted by large telephone companies involves considerable extra work on the part of the exchange operators in the writing of a ticket each time a call is made, giving the calling number, the time and the number called for. An automatic means of accomplishing the same result would considerably increase the capacity of the operators for handling business. Mr. H. T. Richards, 225 W. 28th Street, New York City, has patented a register which automatically indicates at

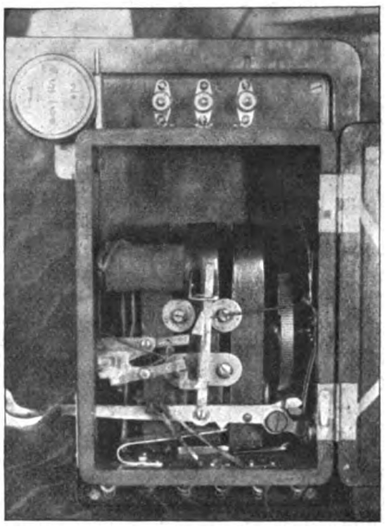


FIG. 2.—THE REGISTER AT THE SUBSCRIBER'S INSTRUMENT.

the subscriber's instrument as well as at the exchange, whenever a call is made. This is accomplished by means of a grounded circuit passing through an electrically operated register for that particular subscriber's line located at the exchange, thence through one wire of the metallic circuit to the apparatus of subscribers' instrument, shown in Fig. 2. At this point the ground circuit passes through an extra contact on the hook switch so designed that the ground connection is only made when the receiver is off the hook. The apparatus is actuated by the exchange operator, who closes the circuit while the instrument is in use and the telephone therefore off the hook. This operates the register at the exchange by means of an electromagnet and fastens the hook switch at the subscriber's instrument to the register, so that when the telephone is replaced on the hook the register is moved ahead. Thus the register can only be advanced while the telephone is in use and yet it is not automatic, and consequently recording all calls whether they should be paid for or not.

### A RINGING GENERATOR ACTUATED BY BATTERIES.

The Eureka Electric Company, Chicago, Ill., is placing upon the market what is known as the Eureka central energy generator. This piece of apparatus, which is shown in Fig. 3, is especially designed to take the place of hand generators in telephone exchanges where power for driving generators is unavailable or where the cost of such driving is so high that a cheaper means of ringing is desirable. Four cells of any ordinary type of salammoniac battery gives the power which the apparatus shown in the cut converts inductively into a high voltage and sufficient quantity to ring bells over lines having resistances as high—it is claimed—as 100,000 ohms.

Unlike some battery driven generators designed in the past, the vibrator only runs when it is desired to signal a subscriber, in consequence of which the batteries are not exhausted when the apparatus is not in use. The circuit is closed either by a cam lever upon the Eureka metallic express switchboard or by a foot push, which is furnished with the machine for use upon other boards. The instrument is adapated for either series or

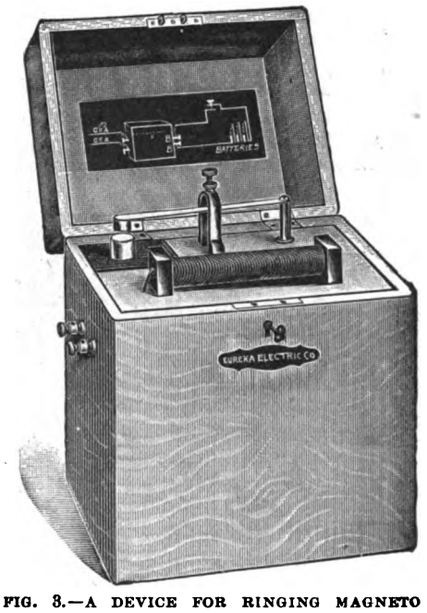



FIG. 3.—A DEVICE FOR RINGING MAGNETO BELLS WITH BATTERY CURRENTS.

bridging lines. Its size is 10x12 ins. and it can be placed wherever convenient, either at the switchboard or away from it.

### A SIMPLE MOTOR STARTING BOX.

As many of the authorities no longer require motor starting boxes with an overload release the C. & C. Electric Company, New York City, has put on the market the type "A" starting box, fitted only with a low-voltage releasing device, the simplicity of which can be readily seen from the illustration, Fig. 4. The box

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consists simply of a case of cast-iron containing the resistance coils wound on asbestos tubes, and a face plate of polished slate to which are bolted the removable brass contacts, the contact lever, with its spiral spring, and the iron-clad release magnet. The winding of the latter is

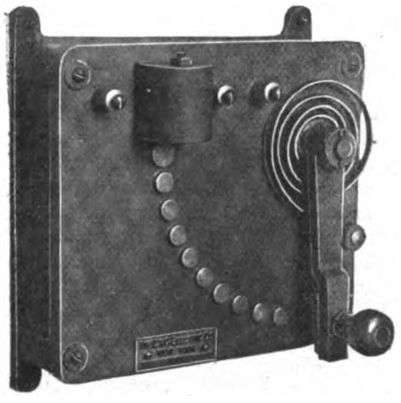


FIG. 4.—A MOTOR STARTER WITH UNDER-VOLTAGE RELEASE.

connected in series, as usual, with the motor field, and its poles engage and hold an armature attached to the contact lever when the latter is in the running position.

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AN AUTOMOBILE WITH BOTH GASOLINE AND ELECTRIC MOTOR DRIVING EQUIPMENTS.

By combining the gasoline engine with an electric motor for vehicle driving the engine can be made lighter than that required to alone drive the vehicle up the heaviest grades. The disadvantage of poor starting apparently inherent in the gasoline engine can be entirely overcome, and the motor and battery can be made much lighter than though they alone were required to supply the full power, as the battery is alternately charged and discharged at short intervals from the engine and is not dependent upon power houses for charging current.

A line of vehicles driven in this manner has been put on the market by the Munson Company, La Porte, Indiana. The driving gear upon these vehicles is shown in Fig. 5. The engines are horizontal and of the twin cylinder type, with balanced cranks and electric ignition. The igniters are supplied by the storage battery of the dynamo and fitted with spark coils specially wound for the high pressure, 40 volts. To prevent the grounding of the circuit both contacts of the igniters are insulated from the engine castings.

Coupled to the engine shaft is the generator or motor, which is of the external armature type, narrow and of large diameter in order to obtain maximum flywheel capacity with a given weight. The dynamo has a ring armature with a series or two circuit winding and a radial or disc commutator. The internal field has six poles energized by a single field coil, shunt wound and divided electrically into two halves, connected respectively to each of the two trays of storage cells, so that the series multipling of the trays does not affect the field excitation. The dynamo is enclosed in a dust and moisture-proof casing.

Two sizes of dynamos have so far been made, one rated at 3 h. p. and the other at 5 h. p. The smaller machine has a speed of 360 r. p. m. when running free on 80 volts; its weight is 300 lbs. and its dimensions are 18 ins. external diameter by 8½ ins. width over all. The larger machine has the same speed, slightly larger dimensions, and its weight is 425 lbs.

By means of the controller the two trays of the battery can be connected either in series or parallel, giving to the motor two speeds, one double the other as the machine is shunt wound, and a further speed variation is obtained by means of a changeable gear. This gear is changeable in a ratio of 4 to 1, so that there are two speeds on each gear, giving 4 speeds to the vehicle altogether. A reversing switch is used for backward movements by means of the motor alone, there being two backward speeds. There is one resistance position of the controller, with the batteries in parallel, and also one when they are in series, but the controller mechanism is not fitted with notches in these positions.

With the larger sized motor two makes of battery have been employed, one outfit weighing 800 lbs. and rated at 100 ampere hours at 80 volts; the other weighing 650 lbs. and rated at 75 ampere hours at the same pressure. Owing, however, to the quick recharging of the battery as soon as the driving of the vehicle requires less power than the engine generates, it has been found that a much lighter battery can be used and give proper results. Both pleasure vehicles and delivery wagons have been built with driving gears of this kind.

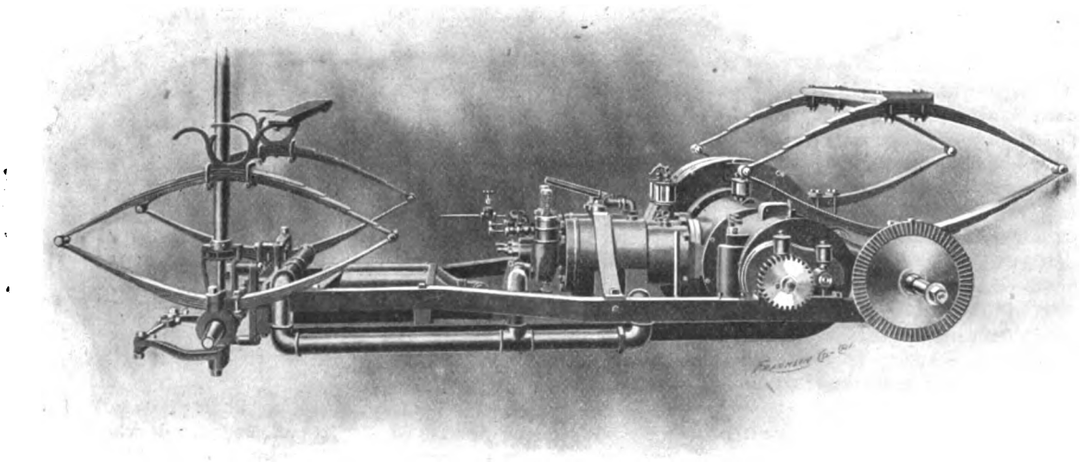


FIG. 5.—A COMBINED GASOLINE AND ELECTRIC MOTOR VEHICLE EQUIPMENT.

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THE SUSPENSION OF THE PITTSBURGH TRANSFORMER.

The type "K" transformer made by the Pittsburgh Transformer Company, Pittsburgh, Pa., recently described in these columns, has been provided with a convenient form of suspension shown in Fig. 6. The case itself is cast with four slotted lugs which can be slipped over the heads of lag screws for suspension on buildings or other similar surfaces. In addition to this each transformer is supplied with a pair of hanger irons, as shown in the illustration, with studs designed to enter the slots on the lugs of the case, the irons being bent at their upper ends, as shown, in order to conveniently hang over a cross arm. The outward bending is designed to allow the two hangers to be placed respectively on opposite sides of the pole so that the transformer may hang immediately below the center of the cross arm and against the pole. The Pittsburgh Transformer Company announces that it is meeting with largely increased sales and has enlarged its manufacturing facilities in order to

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supply this increased demand. Besides its line of standard transformers it is now building a number of remarkably high voltage transformers with a ratio of 40,000 to 5000 volts. These are for use in a western installation.

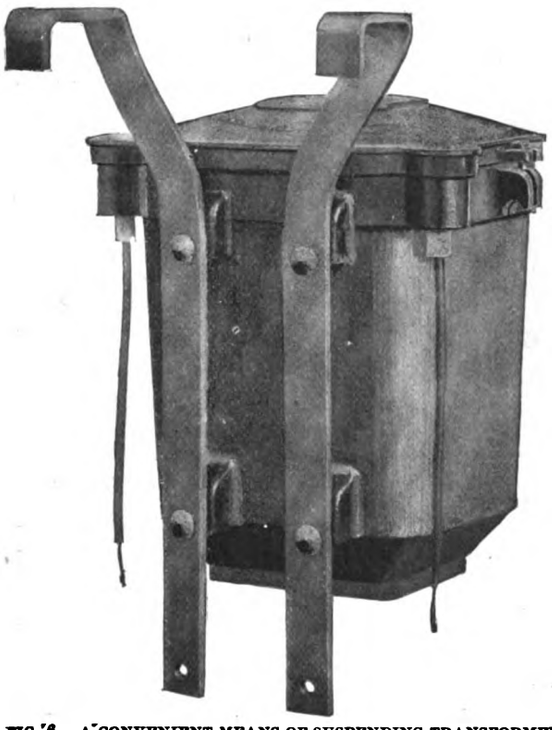


FIG. 6.—A CONVENIENT MEANS OF SUSPENDING TRANSFORMERS.

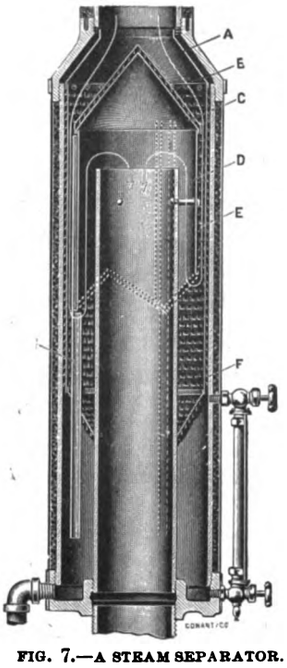



FIG. 7.—A STEAM SEPARATOR.

### THE DIRECT STEAM SEPARATOR.

The operation of the separator, shown in Fig. 7, is as follows:

The accumulated moisture around the walls of the steam pipe is caught by the upper edge of cone A and carried down back of the lining to the water chamber. The current of steam entering the separator impinges upon the conical surface composed of solid plate C, covered with sieve B, through which water may freely pass, but from which it cannot readily escape. Passing through the sieve and depositing on the solid surface of the cone, C, this water is carried by conductors to the water chamber. By means of the cone the column of steam is changed to an annular ring, which is comparatively thin, even while the full area of the pipe is maintained. The steam upon the outside of this ring comes in contact with the lining of the shell, which has a sieve of the same character, as at B, and which catches and entrains any water which may be contained in that portion of the current. There is also provided a lip at lower edge of the inverted cup, which leads all the water that may adhere to its surface down to the conductors to the water chamber. The current of steam passes through the passages indicated by white lines, and is subjected to a whip-snapping action which will throw off any moisture which has not been caught by the surface over which it has passed.

The diaphragm, F, prevents the steam from picking any water out of the water chamber. The plate, C, is a substantial gray iron casting resting securely upon three castings hooked over the top of and securely riveted to the inner pipe. The trapping sheets are of heavy gauge cold rolled copper and the construction is in every way as secure as the best judgment of the inventor, backed by five years' experience in this business, can make it. Every machine is tested at 250 lbs. pressure before shipment and covered with the best non-conductor and a polished jacket, making it in appearance suitable for attachment to any of the highly finished engine cylinders.

These separators are made by the Direct Separator Company, Syracuse, N. Y. Professor Sweet is the inventor of the separator.

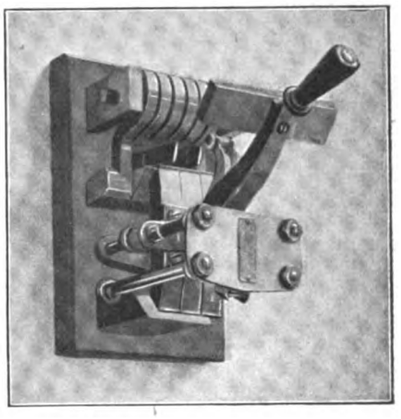


FIG. 8.—AN UNDERLOAD CIRCUIT BREAKER.

### A NEW CIRCUIT BREAKER.

The contact between the heavy blades and clips of very large switches or circuit breakers is intimate over the whole surface and of low resistance only when the parts are ground and accurate in

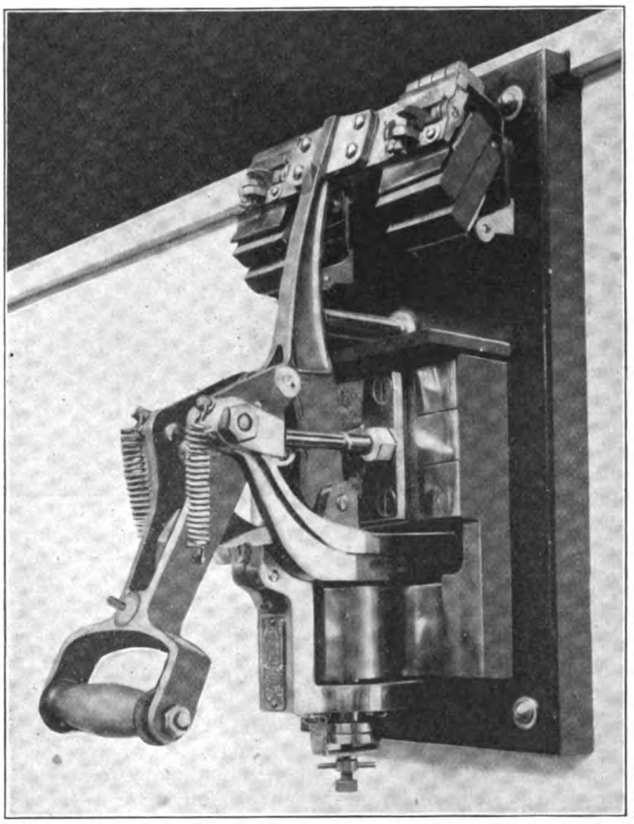


FIG. 9.—THE I. T. E. CIRCUIT BREAKER, WITH LAMINATED LEAF CONTACTS.

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alignment and forced together under considerable pressure. For the transmission across the contact of the very large currents of large installations this necessitates parts of considerable weight, and consequent cost at the present price of copper, in addition to which the rubbing pressure upon the moving parts makes them difficult to manipulate. The Cutter Company, Philadelphia, Pa., has brought out a new form of the I. T. E. circuit breaker, utilizing as its main or primary contacts the ends of thin laminated leaves instead of the blades and clips used up to the present. The instrument embodies several other improvements in circuit breaker construction which are shown in Fig. 9, reproduced from a photograph of a 1500-ampere breaker designed for railway voltages, and exhibited at the New York Electrical Show.

The main contact consists of a lot of fine springy leaves extending across the body of the instrument and forced back by a toggle joint, connected to the handle, giving a pressure of a good many hundred pounds with considerably less force than that required to manipulate the older types of breakers. The leaves are slightly curved at their ends so that as they are forced between the wedge-shaped contact blocks they will take a true bearing. The secondary break is at the top of the instrument, removing from the other parts any arcs that may tend to form. The carbons are on the end of a long arm which is forced into position by means of the wedging action of the handle and thrown out very quickly when the trigger releases it. As the delicate leaves of the primary break are more likely to injury in case the secondary does not make a good contact and the arc is thereby transferred to the primary, there is a double path through the secondary contacts at the top of the instrument. Just above the carbons will be noticed a copper contact which acts as a low-resistance shunt to the primary leaves below, opening after they do, but before the carbons separate. There are thus in this breaker three paths for the current opening in the following order: First carbon, second copper, and third, main copper leaves.

Fig. 8 shows a smaller breaker designed for underload release for storage battery or similar work. Here the releasing device is simply an armature across the poles of the magnet at the top of the instrument. A little secondary break is provided in the form of a short rod entering between two clips in the middle of the instrument. The primary leaves in this case run vertically and the arrangement of the wedge-shaped contacts is clearly shown as the instrument is illustrated in the open position.

### A CONVENIENT BORING TOOL.

For boring holes in joists or under partitions from floor pockets or similar positions difficult of access, the Anthony joist machine or universal boring tool shown in Fig. 10 is particularly convenient. The machine works without a ratchet, giving the bit a continuous rotation. There is a long range for adjustment from the guide to the bit. The main handle is also adjustable and the machine can easily be taken to pieces for packing in a grip or

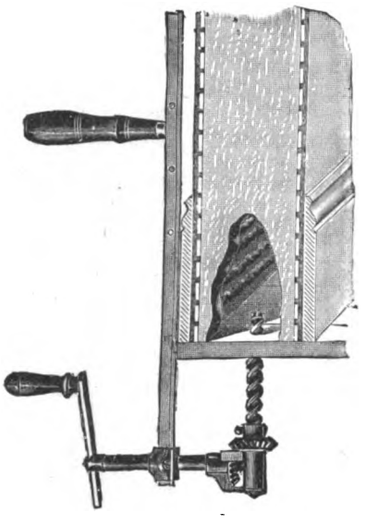


FIG. 10.—A CONVENIENT BORING TOOL.

tool box. It is made by the American Electric Company, Detroit, Mich.

### A HIGH TENSION GENERATOR.

The arrangement of the parts of rotating field machines so that both the field and armature coils shall be accessible for replacement or rewinding is necessarily

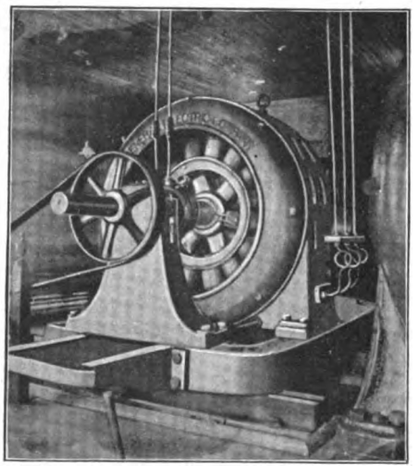


FIG. 11.—A HIGH TENSION REVOLVING FIELD DYNAMO.

somewhat different from that of machines with rotating armatures. The external stator, if it carries a multiphase winding cannot be split so that the top can be removed or either half moved out laterally from the shaft. The machine must then be made so that either the rotor can be moved out axially from within the stator or the stator slid endwise to clear the rotor. Fig. 11 shows the arrangement adopted by the General Electric Company in machines of this type. It will be seen that the base carries a bracketed extension and the shaft is extended considerably beyond the exciter pulley. Close examination will also show, although it does not appear very clearly in the illustration, a strut from the external stationary armature to the pedestal in the foreground. A number of holes will also be seen in the casting which forms the base plate of the machine. The general purpose of these devices is to allow the external armature and the one pedestal in the foreground to be moved along the shaft such a distance that the coils will completely clear the field poles and allow the ready repair of either. This is accomplished as follows:

The exciter pulley is removed, as are the bolts holding the pedestal and the armature shell to the base plate; a small jack-screw is then inserted in one of the holes in the base plate behind the armature shell casting, on each side of the machine, and screwed up to push the parts forward along in the direction of the shaft, the pedestal moving out on to the bracket shown. By this means a coil may be replaced or a new field pole put in in a short time without the use of any crane or tackle and without any serious dismantling of the machine. The illustration shown is that of a 250 kw. 10,000-volt generator, supplying three-phase power to a transmission line running to Portland, Maine.

### AN IMPROVED LAMP SOCKET.

The new regulations of the National Electrical Code specify several detail changes of lamp sockets that make new models necessary. Among these are the

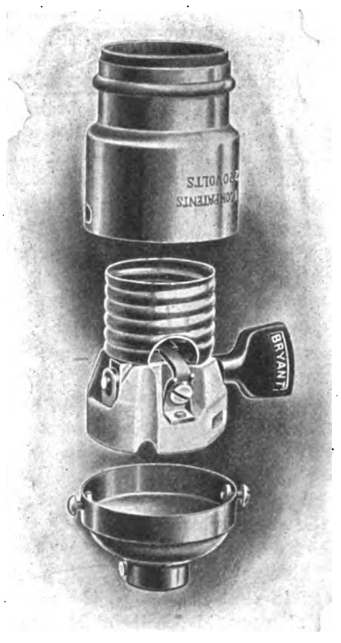



FIG. 12.—A LAMP SOCKET COMPLYING WITH THE NEW UNDERWRITER'S REGULATIONS.

requirements that the shells must be lined with an insulating material and that the socket must be able to safely stand any pressure up to 250 volts. The Bryant Electric Company, Bridgeport, Conn., has modified its standard Edison socket to

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meet these regulations, the appearance of the new socket being shown in Fig. 12. The arrangement of the parts is clearly shown in the illustration. This socket will be in the hands of the principal jobbers by the date on which the requirement goes into effect, viz., July 1.

### AN AUTOMATIC CIRCUIT BREAKER.

The increasing popularity of the circuit breaker in place of the fuse has brought on the market several new types and makes, one of which is made by the Fisher Electrical Manufacturing Company, Detroit, Mich., and shown in Fig. 14. As will be seen, the moving parts of this instrument slide vertically instead of swinging from the switchboard, giving more rigid alignment than can be obtained by hinges. The handle for restoring the breaker is so arranged as to give great leverage and consequent ease of manipulation. The secondary or carbon breaks are placed outside the main contacts, keeping the arcs well away from each other to avoid any danger of jumping across. There are also no metallic parts between the two poles of the instrument to which the current can jump.

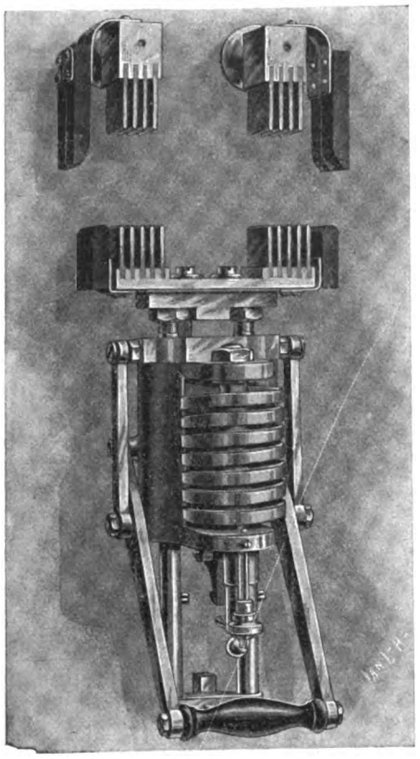


FIG. 14.—AN AUTOMATIC CIRCUIT BREAKER.

### THE AULTMAN CHAINS FOR POWER TRANSMISSION AND ELEVATING AND CONVEYING PURPOSES.

The Aultman Comapny, Canton, Ohio, has recently placed on the market a complete and novel line of chains for the transmission of power and elevating and conveying service.

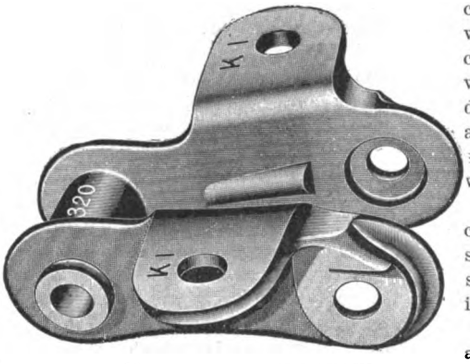



FIG. 16.—A PINTLE TYPE CHAIN.

The salient features of the chain shown in Fig. 15 are strength, durability and moderate first cost. The side bars are interlocked with each other. The renewable wearing band or sleeve is socketed into the inner face of the side bar, but is entirely free to turn in the socket and around the bolt. The working strain is borne largely by the wearing bands or sleeves instead of the bolts. The bolts are secured by a perfect nut lock and need not be riveted unless so desired.




FIG. 17.—A SPROCKET WHEEL FOR CHAIN DRIVES.

The links are thus well protected from dust and grit, but can be readily separated and uncoupled. The uncoupling can be done with the chain as tight on the wheels as it should ever run. For work requiring great strength the chain can be worked in double strand.

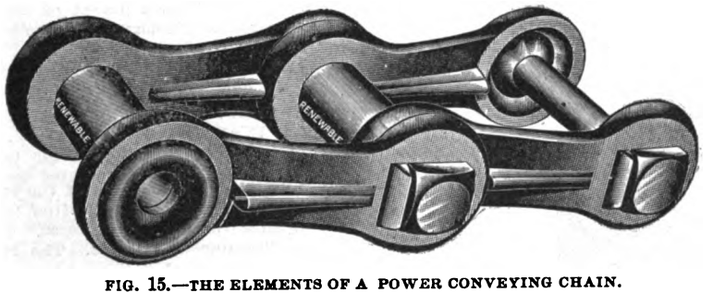



FIG. 15.—THE ELEMENTS OF A POWER CONVEYING CHAIN.

Another case of interlocking chain belt is the pintle type, as illustrated by Fig. 16. The construction of this chain gives great wearing surface and strength with minimum weight. The wear is entirely on the cross bar and interlocking socket joints, which are practically dust-proof. The chain articulates freely and easily, and is well adapted for any purpose common to detachable chain belt. The construction allows the chain to be used with either side to the sprocket, or one side can be worn down and the chain reversed.

Sprocket wheels for the foregoing chains are furnished with chilled teeth or semi-steel mixture where extra severe service is to be met, or the usual grey iron wheels can be had.

Still another departure in chain design and construction is shown in the scraper and conveyor chains illustrated in Fig. 18.

### TESTS OF A STEAM SEPARATOR.

In a paper presented before the last meeting of the American Society of Mechanical Engineers, Mr. F. L. Emory described some tests of the performance of an Austin steam separator of the baffle-plate pattern, designed to serve as a live steam separator, as an exhaust steam separator or trap, or as an oil extractor. The method of testing consisted in brief of a determination of the quality or wetness of the steam before and after it passed through the separator. The tests were made at various pressures and velocities and the quality of the entering steam was changed by means of a water jacket by which the steam could be partially condensed and the conditions thereby made peculiarly severe. The quality or wetness of the steam was measured by means of separating calorimeters, checked under those conditions where it was possible, by means of throttling calorimeters, the

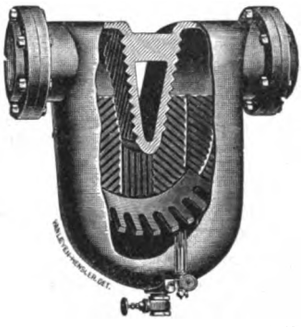


FIG. 19.—A STEAM SEPARATOR AND OIL EXTRACTOR.

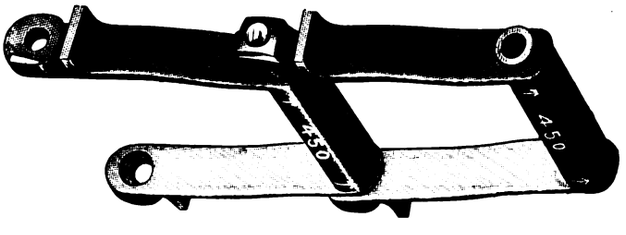



FIG. 18.—A CHAIN FOR SCRAPERS AND CONVEYORS.

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steam being afterwards condensed and weighed, and the drip of the separator being collected and weighed to give a check upon the other factors. The separator used was of the horizontal type, as made by the Austin Separator Company, Detroit, Michigan, and is shown in Fig. 19.

The results of the test were given by Mr. Emory in the form of tables which are rather too long for reproduction here, the conclusions which he drew being as follows: The separator will, if kept well drained, deliver a steam dry within 3 per cent., i. e., of 97 per cent. dryness, no matter what the quality of the entering steam may be, and shows little separating qualities in steam of a dryer quality. There seems to be little difference between its action on live steam of high pressure and exhaust steam of low pressure. Even with pressures as low as 3 pounds above atmosphere, corresponding to ordinary engine exhaust, the separator gave practically the same results, i. e., it allowed to pass through in liquid form only 3 per cent. of the total weight of fluid. The same instrument was tested as an oil extractor by pumping into the entering steam "vacuum" cylinder oil at about the rate of ordinary working conditions in engine lubrication. The oil coming away with the water in the drip from the separator was skimmed and dried; corrections were made for the water added to it, its weight was compared with that introduced, and it was found that about 50 per cent. of the oil was recovered.

### THE NOARK ENCLOSED FUSE.

The lack of safety, accuracy and reliability of action inherent in the ordinary bare wire of a lead alloy, commonly used as a protecting device for electrical circuits, has led to its general condemnation and to the wide use of mechanical circuit opening devices. On the other hand, the cheapness, simplicity and peculiar advantage of a time interval obtained by the thermal action of a fuse have caused its retention in spite of the disadvantages named.

The enclosed fuse has during the last few years been gradually developed to a high state of perfection by which these disadvantages are done away with. In the type shown in Fig. 20, which was designed by Mr. Joseph Sachs and is being introduced to the market by the H. W. Johns Manufacturing Company, New York City, objections which applied to earlier types of enclosed fuses have been overcome. The requirements which this fuse has been designed to meet are as follows:

It must operate with any excess of current above its rating in case this current continues for a time interval inversely dependent upon the amount of the excess. It must open the circuit without arc, flash or bursting and yet positively leave an indication that it is opened. It must be unaffected by time or atmospheric conditions, and of low cost, simple in construction and easy of manipulation.

Structurally the fuse consists of a fibre tube capped at each end with a brass ferrule and filled around the interior fuse wire with a material which absorbs the melted metal when the fuse blows and prevents the formation of a conducting vapor. It is claimed that the action is such that the circuit is not broken instantaneously, which is liable to result disastrously in case of a great amount of self-induction, but the resistance rises to infinity quickly and uniformly as the metal of the wire combines with the surrounding material.

One of the most striking features of this instrument is the simple indicating device which overcomes a great objection to previous types of fuses which give no indication whether the circuit is open or closed. This consists of a fine wire of highly resisting alloy, run outside of the tube between the brass ferrules. When the fuse within blows, the whole current is thrown upon this fine wire which is instantly vaporized, leaving upon the casing a well defined black line. The structural details of the fuses have been well worked out for the various requirements and a complete line of fittings for them has been designed.




FIG. 20.—AN INDICATING ENCLOSED FUSE.

## NEW BOOKS.

Premiers Principes d'Électricité Industrielle. By Paul Janet. Third edition revised. Paris: Libraire Gauthier-Villars. 273 pages, illustrated. Price, 6 francs.

The third edition of this well-known work does not differ materially from previous editions, but contains numerous additions to branches of the science that have been subject to notable developments recently. Among the subjects thus amplified are induction motors and polyphase dynamos and storage batteries, to which recently published information on the subject of rapid charging and discharging and charging at constant potential has been added.

The Commercial and Business Aspects of Municipal Electricity Supply. By Alfred H. Gibbings. Bradford, England. Published by the author, 270 pages, illustrated. Price 15s.

Municipal electric lighting is taking a much firmer hold in England than it has as yet in this country, and this work by the electrical engineer of the city of Bradford gives a very good idea of the present status of this branch of electrical engineering in England. The work was compiled mainly for the use of municipal engineers and committees, the object aimed at being the elucidation of the commercial aspects of electricity supply in such a manner as to present to the ordinary business man the peculiar conditions which differentiate this line of business from the sale of most marketable commodities. Owing to the scarcity of literature on this particular branch of the subject—most works being devoted largely to the engineering aspects—the work should prove particularly valuable to English municipal engineers and of no little value to municipal authorities or engineers in this country contemplating the establishing of municipal plants and desirous of thoroughly informing themselves on all branches of the subject. Some of the subjects most thoroughly treated are: The position of the electricity department in relation to other municipal departments, how to charge for electrical energy, the renting of motors, arc lamps, etc., the prepayment or penny-in-the-slot meters, free wiring and free lamp renewals, the fitting up of a show room with fixtures, etc.

## LEGAL NOTES.

THE CARTY BRIDGING BELL DECISION.—The United States Circuit Court of Appeals handed down a final decision at Philadelphia on June 8th in the case of the Millheim Electric Telephone Company vs. the Western Electric Company. The opinion was on an appeal from a previous devision upholding the well-known patent of 1891 to J. J. Carty for multiple party line combination of telephone apparatus. The final decision upheld the decree of the Circuit Court, holding that the patent is valid and infringed.

THE LITIGATION BETWEEN THE HANCOCK INSPIRATOR COMPANY, of Boston, and the Penberthy Injector Company, of Detroit, has been terminated by the Penberthy Company purchasing of the Hancock Inspirator Company the Loftus "ring valve" injector patent, No. 300,092, upon which the litigation was based. The Hancock Company reserved a license to manufacture injectors under this patent not intended for the farm engine trade. The American Injector Company has for several years had a license under this patent, but desiring an interest in the patent and the dismissal of a suit against it by the Penberthy Injector Company on the Borland patent, it has purchased a one-third interest. It and the Penberthy Injector Company are now the sole owners of the Loftus patent above referred to.

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THE COLLIERY ENGINEER COMPANY, proprietor of the International Correspondence Schools, Scranton, Pa., has brought suit against the United Correspondence Schools, New York City, and the American School of Correspondence, Boston, Mass., for infringement of its copyrights. The preliminary injuction was denied by Judge Lacombe, of the United States Circuit Court, on the ground that it would work irreparable damage to the defendants, and it was thought best to relegate the action to final hearing. The International Correspondence Schools announce that it is their purpose to proceed with all possible speed in both suits to a final determination.

## PERSONALS.

MR. SAMUEL INSULL, president of the Chicago Edison Company, was quietly married in New York City on May 23 to Miss Gladys Wallis, the well-known actress.

MR. A. A. ZIEGLER announces that he has resigned his position as President and General Superintendent of the Ziegler Electric Company, Boston, Mass. Mr. Ziegler states also that he expects soon to enter again into the same line of business.

MR. FRANK G. BOLLES has resigned his position as advertising designer and writer of special literature for the Westinghouse Electric and Manufacturing Company, and has accepted the management of the advertising department of the Bullock Electric Manufacturing Company, of Cincinnati.

PROF. WILLIAM S. ALDRICH, heretofore of the West Virginia University, who is well known to readers of the American Electrician through his contributions to its columns, has just been appointed to the chair of electrical engineering of the University of Illinois, Champaign, Ill.

MR. F. S. PEARSON, chief engineer of the Metropolitan Street Railway Company, New York City, and famous for his work in open conduit systems, sailed on June 5th for San Paulo, Brazil, to look at the development of a street railway and lighting system to be installed by the Pearson-Mackenzie Syndicate. A water power will be utilized and a small steam plant will be temporarily installed for immediate service.

MR. JOHN S. STONE, formerly of the engineering staff of the American Bell Telephone Company, has opened an office in the Phillips Building, Boston, as an electrical engineer and expert. Mr. Stone's work on the modern development of American Bell apparatus, chiefly the relay and visual signal systems, has been both extensive and valuable, as the records of the patent office for the last few years show, so that his services will undoubtedly prove to be of value to any one needing expert work in telephony.

MR. W. F. KELLY, formerly with the Columbus Street Railway Company, Columbus, Ohio, has resigned from his position there to become the railway manager of the Safety Third Rail Electric Company, New York City. It is the purpose of the banker, Mr. Emerson McMillin, who is heavily interested in the Safety Third Rail property, to actively push its interests, and his choice of Mr. Kelly, who has seen considerable service in the McMillin property at Columbus, speaks well for the latter's managerial ability.

## TRADE PUBLICATIONS.

THE H. C. ROBERTS ELECTRIC SUPPLY COMPANY, Philadelphia, Pa., has circulated a new catalogue of tools and appliances for electric light, railway, telegraph and telephone construction.

THE MASON REGULATOR COMPANY, Boston, Mass, has published a catalogue descriptive of the Mason speed governor for steam pumps. The catalogue is a most complete one, showing and describing every detail of the internal construction of the governor, so that its operation can be clearly understood.

THE UNITED ELECTRIC HEATING COMPANY, Detroit, Mich., has issued a new illustrated price list describing several new additions to its list of manufactures, among them a new portable stove, a curling iron heater and a new soldering iron made of aluminum. The company reports the demand for its goods greater than ever before.

YE DECLARATION OF INDEPENDENCE is something that every one has heard about but which it is hard to lay hands on when the occasion arises to refer to it, as it does about this time of the year. The John A. Roebling's Sons Company, New York City, has published a neat pamphlet showing a fac-simile of the original document as well as a copy in type, which can be had on application to the company.

THE DETROIT LUBRICATOR COMPANY, Detroit, Mich., has just gotten out a new line of glass body oil cups and glass body oil pumps. The oilers, while simple in design, are equipped with all the latest improvements, including the set feed and stop feed features, and are well and strongly made, with cast tops and bottoms. The company has also issued some printed matter descriptive of these devices.

A. L. IDE & SONS, Springfield, Illinois, have issued a new catalogue of the Ideal engines. Besides describing and illustrating with remarkable clearness all the details of the engine, the catalogue also shows a number of special equipments and devices such as the Ideal throttle valve, steam separator, reducing motion, power transmitter, belt tightener, etc.

THREE HANDY POCKET CATALOGUES, or rather descriptive pamphlets, are those recently published by the Westinghouse Electric & Manufacturing Company on the Wurts non-arcing lighting current and the Westinghouse alternating current and direct current fan motors for 1899. The first of these lists the various styles of Wurts arresters for stations and line use on either direct or alternating currents with the choke coils for use therewith. The others describe and illustrate the fan motors previously described in these columns.

SCHEEFFER WATTMETERS.—The Diamond Meter Company, Peoria, Ill., has published a new catalogue of the Scheeffer recording wattmeters for alternating currents. The new catalogue is of particular value to central station men, whether they use Scheeffer meters or not, owing to its complete detailed instructions for the calibraton of meters. The catalogue also lists convenient pieces of apparatus for use in testing meters, among them a rheostat to give graduations of the load between lamps, and a convenient leveling table for mounting the meters.

THE WARD LEONARD ELECTRIC COMPANY, Bronxville, New York, has a classification of its rheostats which renders it a simple matter to determine just what rheostat is wanted for any given service. The number of ohms of resistance of each instrument is given as well as the maximum number of amperes which it will carry continuously with the entire rheostat in circuit and the maximum number of amperes which it will carry continuously with only one step or section in the circuit. A catalogue recently issued gives the prices of the company's complete line of seven styles based on these classifications.

RURAL SUMMER HOMES is the title of an illustrated guide to the summer homes adjacent to New York on the Erie Railroad and its branches. The volume is as attractive in appearance as a high-class illustrated magazine and gives complete detailed information on all points which a prospective summer boarder could wish to learn about. Besides the general description of the country, which is attractively written, the guide contains lists of the hotels and boarding houses, giving rates, capacity for guests, distance from stations, means of conveyance and other details. The work also contains many illustrations of these places of temporary abode as well as a topographical map of the lines.

THE EMERSON ELECTRIC MANUFACTURING COMPANY, St. Louis, Mo., has published a small pamphlet which central station men would do well to obtain in quantities and distribute to their patrons. The pamphlet is entitled "Use Electricity in Your Home and Business," and describes and illustrates the various devices by which alternating current can be made use of, especially in the home. Among these devices are desk and ceiling fan motors, a sewing machine motor, motors for small power users and for small factories, special types for church organs and blacksmiths' blowers. A line of electrical heating apparatus is also described, as well as enclosed arc lamps, a watch demagnetizer, surgical transformer for cautery, and a phonograph motor.

## BUSINESS NEWS.

THE HARDY LAMP COMPANY, Pittsfield, Mass., is actively pushing arrangements for doubling the capacity of its plant in anticipation of a very busy fall season.

GEORGE WILLIAM HOFFMAN, Indianapolis, Ind., states that he has just shipped to Canada a large order of his U. S. metal polish.

THE ELECTRIC STORAGE BATTERY COMPANY has moved its general offices in Philadelphia to the new factory building, 19th Street and Allegheny Avenue.

THE FALK COMPANY BURNED OUT.—The entire establishment of the Falk Company, at Milwaukee, Wis., including shops and offices, was destroyed by fire on June 13th.

THE W. H. ELLIOTT ELECTRIC COMPANY, Cleveland, O., has recently removed its factory to 1076 West Hamilton Street, where it will have exceptional facilities for its class of work.

THE HOLTZER-CABOT ELECTRIC COMPANY, Boston, Mass., is making an addition to its factory, necessitated by its largely increased business. The new building is 60 x 40 ft. in size and three stories high and will contain about 10,000 sq. ft. of floor space.

THE ZECO ENCLOSED DIRECT CURRENT ARC LAMPS have evidently found favor with central station managers, as is shown by that best expression of appreciation, repeat orders, a large number of which have reached the Central Electric Company, Chicago, Ill., during the last few months.

THE VAN DORN COUPLERS, made by the W. T. Van Dorn Company of Chicago, Illinois, described in the last issue of the American Electrician, have been adopted as the standard on the elevated roads of Chicago and of Brooklyn, and are in general use on some 200 surface roads in this country.

THE ALLEN-HUSSEY COMPANY, manufacturer of interior telephones, having principal offices in New York and Chicago, reports placing new agencies in several of the larger cities during the past months. The company has issued a sheet of diagrams of wiring, illustrating the many uses of its specialty, interior telephones.

A GENERAL ELECTRIC DIVIDEND.—At a meeting of the directors of the General Electric Company, held on May 22, a dividend of one and one-half per cent. was declared upon the reorganized common stock, payable July 15. The directors expect to declare quarterly dividends at this rate here-

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after. Books for the dividend close June 30 and reopen July 17.

THE AMERICAN WOVEN WIRE BRUSH COMPANY, Peabody, Mass., has been under new and progressive management since March of this year, and its business has greatly improved, owing to the fact that it is making better brushes and more prompt deliveries. The company announces that it has facilities for filling orders of any probable size for these goods from jobbers and users.

THE INTERNATIONAL CORRESPONDENCE SCHOOLS, Scranton, Pa., have had constructed two special combined sleeping and exhibit cars for the railway department of the schools. These will be sent around the country to give an impressive exhibit of the company's work. One of them has already gone to the Railway Master Car Builders' Convention at Old Point Comfort, Virginia.

THE ENTERPRISE ELECTRICAL COMPANY, Cleveland, O., has completed its contract for the equipment of the Hollenden Hotel of that city. The installation includes a 400 number Partrick, Carter & Wilkins patent needle annunciator, together with telephone room sets and fire alarm attachments. The Partrick, Carter & Wilkins annunciator system is very popular among hotel proprietors, some of the largest and finest hotels in the United States being equipped with that apparatus.

THE HOPPES MANUFACTURING COMPANY, Springfield, Ohio, reports cases of that best of recommendations, a repeat order, from many well-known firms, among them the following: The Deering Harvester Company, two 1250 h. p. purifiers; The Louisville Railway Company, three 625 h. p. purifiers; the Danville Gas, Electric Light and Street Railway Company, 1000 h. p. purifier; the Jeffrey Manufacturing Company, 500 h. p. purifier and 500 h. p. heater.

THE INSTITUTE FOR HOME STUDY OF ENGINEERING, of Cleveland, has recently been incorporated with the United Correspondence Schools, of New York. The consolidation will result in great benefit to the students of the Cleveland Institute. All contracts with students will be carried out and they will have the advantages resulting from the large capital, increased facilities and the improved and perfected courses of the United Correspondence Schools.

THE PELTON ENGINEERING COMPANY, Cleveland, O., has recently moved to Hamilton Avenue, near Belden, where it has a space nearly three times as large as their old quarters. Mr. W. H. Pelton, the manager of this concern, recently stated that as far as business was concerned there was no summer season with his company, as there was no diminution of orders, and that the company had already an amount of business booked that would carry it well into the fall.

THE AMERICAN ENDOSCOPIC COMPANY, Providence, R. I., has put on the market a convenient electric hand light called the "Little Rhody." This consists of four cells of dry battery mounted in a case with a handle, switch, lamp socket and reflector. The apparatus complete weighs just 18 oz. and measures 9 in. in length, including the lamp and reflector, by 1¼ in. in width and 2½ in. in heighth. The sets are made in three different styles of finish. The batteries will run 10 consecutive hours and a new battery can be put in at a small cost.

THE SLOW DEPRECIATION OF STURTERVANT FANS.—The wonderful endurance of a well designed and thoroughly constructed fan blower is emphatically evidenced by a recent statement of The William Kennedy & Sons, Ltd., Owen Sound, Can., to this effect: "We have two Sturtevant pressure blowers in use, one of which has run over 32 years steadily, and often 24 hours per day, and is apparently as good as when installed, although no one has as yet seen the inside of it. The other has been used for foundry purposes, and has been in use for about 30 years or so."

THE DIRECT SEPARATOR COMPANY, Syracuse, N. Y., reports a large number of sales during May and June, one party having sent a duplicate order for eighteen steam separators; another the tenth order for four large ones, making thirty-nine separators in the service of this one user. Another company sent in its forty-ninth order, making one hundred separators in its use. These duplicate orders, of which the makers have received so many, are increasing all along the line. During the above two months to June 12th, twenty-two such orders, covering fifty-eight machines, were received.

THE HARRISON SAFETY BOILER WORKS, Philadelphia, announces a large list of recent sales of Cochrane feed water heaters and Cochrane separators. Among the largest orders for the former were 10,000 h. p. for the Ohio Steel Company, 6000 h. p. for the Alabama Steel and Wire Company and 1000 h. p. for the Gabriel Electric Company. Of separators—three 16 in. and one 10 in. were sold to the Carnegie Steel Company, one 14 in. to the Gisholt Machine Company, one 16 in. to the Alcania Electric Company, a large order of various sizes to Laughlin & Company, Ltd., besides many of the smaller sizes.

MANUFACTURERS OF ELECTRIC AUTOMOBILES would do well to correspond with the Mica Insulator Company, New York and Chicago, in reference to "Micanite" insulation. This concern is especially equipped for the manufacture of commutator rings and segments for motors of this class of work. The "Empire" and "M. I. C. Compound" cloths and papers are being used quite extensively by manufacturers of motors for electric vehicles. The company offers to send to any manufacturer of such motors a set of rings and segments for trial, free, together with samples of "Micanite" and "Empire" insulating cloth and paper.

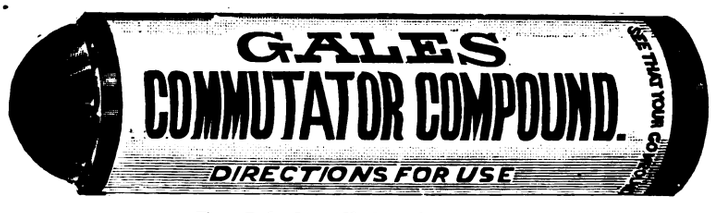
THE MURPHY AUTOMATIC SMOKELESS FURNACES, installed in the National Carbon Company's works, Cleveland, O., have now been in operation several months, and the superintendent says: "We are saving at the rate of twenty dollars per day (24 hours) now as compared with cost of our steam when using a hand stoked furnace." The equipment of the entire plant of 1600 h. p. cost about seven thousand dollars. The Murphy Automatic Smokeless Furnaces, installed in the Raritan Copper Company's new works at Perth Amboy, N. J., have very complete systems of coal and ash handling, and all are giving excellent satisfaction. The coal used is bituminous "run of mine" from the "Beach Creek," Pa., district, yet the chimney is practically as clean as where anthracite is used.

THE WESTERN ELECTRIC COMPANY, in addition to its complete line of fan motors, is also building a complete line of power motors from 1/36 horse power up to 15 horse power in the encased and semi-encased open type style, and larger sizes in the open type style. The company has recently constructed an extensive arc light switchboard for the Ottawa Electric Company, Ottawa, Ontario. The board is built of marble panels, and mounted in an iron frame. It is designed for 24 circuits and 24 arc dynamos. The Western Electric Company is installing in Hillman's Department Store, Chicago, one 60 kw. and one 100 kw. 110 volt generators, and a 2-panel 5-circuit switchboard. 112 Petite arc lamps and 1500 incandescent lamps will be used for the interior illumination of the store.

A NEW BATTERY MANUFACTURING PLANT IN ST. LOUIS.—The Phoenix Carbon Manufacturing Company, St. Louis, Mo., has sold its electric light carbon and motor brush departments to the National Carbon Company, of New Jersey. Immediately after this transaction was completed the Phoenix Battery Manufacturing Company was organized, with a full paid-up capital of $250,000. This company has just purchased a tract of land, of about eight acres, located in the southwestern part of St. Louis, adjoining the line of the Missouri Pacific Railway. It will at once begin the construction and equipment of what it claims will be the largest battery manufacturing plant in the world. Among the gentlemen interested in the enterprise is Col. S. G. Booker, who has for many years been prominently identified with battery-carbon manufacturing interests.

ENGLISH PRESSES DRIVEN BY AMERICAN MOTORS.—The Bullock Electric Manufacturing Company, Cincinnati, will ship to England this month one 25-h. p. generator and two 30-h. p., one 40-h. p. and two 30-h. p. printing press equipments for the Manchester "Sporting Chronicle." One 28-h. p. type 0 printing press motor, with controller, will go to Cassell & Co., London, the


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largest publishing house in England. A slow-speed motor for direct connection to a lithograph press, with controller, will be forwarded to the Belfast "Evening News." which will also take a 30-h. p. printing press equipment, with teasers and controller. Two 30-h. p. motors for large presses, with teasers and controllers, will be dispatched to the London "Daily News." These shipments will be the most important that have ever been made from this country to newspaper establishments on the other side.

GATES & RANDOLPH have taken offices and warerooms at 13 and 15 Monadnock Building, on the ground floor, Chicago, formerly occupied by Sargent & Lundy. They are handling the apparatus of the Triumph Electric Company, Cincinnati, Ohio, for direct current work; the Warren Electric Manufacturing Company, Sandusky, O., for alternating work; the Empire Electrical Instrument Company, New York, for portable switchboard alternating and direct current instruments; F. A. La Roche & Co., New York, for switchboards, circuit breakers and switches; Sterling Arc Lamp Company, New York, inclosed arc lamps for all circuits. It is the purpose of Gates & Randolph to operate a miniature electric lighting plant in their new warerooms, using a Triumph motor, running a Warren alternator through a La Roche switchboard, with Empire instruments and transformers, etc., with arc and incandescent lamps and motors running from the same circuit.

THE COLUMBIA ELECTRICAL SUPPLY COMPANY opened its new headquarters at 93 Liberty Street, New York City, on June 21st. The establishment at 329 Fourth Avenue, New York, will hereafter be run as a branch store, as will that in Albany, N. Y. The new headquarters are admirably located in the center o fthe engineering office district in New York City and consist of three floors, the ground floor, basement and sub-basement each about 100 ft. by 25 ft. in size. The lower floors are admirably arranged with bins and shelves for the complete stock of lighting and telephone supplies and electrical house goods which the company will carry, one ingenious detail being the inclined racks for the storage of moulding. The officers of the company are: T. M. R. Meikleham, President; H. P. Douglas, Vice-President; J. S. Douglas, Treasurer; W. B. Dinsmore, Jr., Secretary. Two other men well known in electrical supply circles and now connected with the sales department of this company are Messrs. Geo. Stanmore and J. C. Moulton.

THE MONTAUK AUTOMATIC THERMOSTATIC FIRE DETECTIVE CABLE covers a field which heretofore, electrically speaking, has but tentatively been occupied. Messrs. Stanley & Patterson, New York, among other installations, have recently placed an equipment in the home of Mr. Joseph Pulitzer, of the New York "World"; the firm of Doscher & Hartwell, electrical contractors, among other installations, has recently equipped the winter residence of Mr. George Taylor, in New York City, and also his summer residence on Long Island; the Jenney Construction Company, New York City, is doing a prosperous business in the installation of this cable, and among the many installations made by it may be mentioned the winter and summer residences of Mr. A. A. Cowles, President of the Ansonia Brass and Copper Company. Among the various installations made by the Gamewell Auxiliary Fire Alarm Company, the Dundee Chemical Works, Passaic, N. J., and the Jessup & Moore Paper Mills, Wilmington, Del., may be cited.

A UNIQUE FEATURE of the city of Detroit, the so-called City of Conventions, is the novel welcome extended by the City Council to the various conventions which gather there during the summer. Across the entire face of the city hall, which faces the large square known as Campau Place, the center of the city, is a large skeleton frame work on which is erected a large electrical sign. This sign is changed from day to day or as occasion arises by the visits of various conventions. The signs are very handsome ones and the entire work is in the hands of the Michigan Electric Company, which has contracted to furnish 50 changes at a total cost of frame and letters of about $1,400 for the season of 1899, exclusive of the labor of changing the signs. This makes the cost approximately for each sign about $35 or $40, but after this year the average cost per convention will be only about $10. The average sign includes about 7 four-foot, 54 three-foot and 65 two-foot letters, besides punctuation. The current is furnished by the city from its public lighting plant and the average number of lamps which is used is between four and five hundred of four c. p. each. By this method the city extends a direct welcome to each visiting convention. When the writer last visited Detroit, across the face of the city hall was a brightly illuminated sign reading "Welcome Der Allgemeine Arbeiter bund von Michigan."

CLEMENT & GHARKY.—Mr. Edward M. Clement and William D. Gharky have formed a co-partnership for the purpose of patent solicitation with offices in the Stephen Girard Building, Philadelphia, and the McGill Building, Washington, D.C. Mr. Clement received his education at the United States Naval Academy and afterward entered the office of one of the old Washington law firms as a student. In 1890 he entered the U. S. Patent Office as an assistant examiner and in 1891 after a year's experience in hydraulics, was sent to the electrical division, where he remained for nearly seven years. During this time he had charge at


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The Scope of the New York Telephone Service

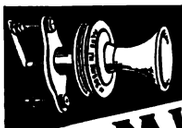
is so great that practically every town and city within a radius of over 1000 miles of the City Hall is within speaking distance of every New York telephone.

The immediate neighborhood of New York—Long Island, Westchester and New Jersey—is well provided with telephones.

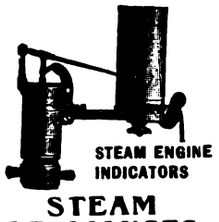
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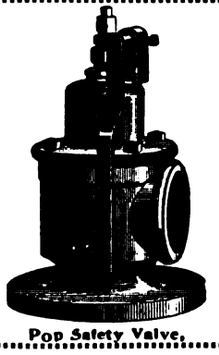


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different itmes of telephonic and telegraphic work particularly, but examined cases in all classes. He resigned about a year ago and opened an office in the McGill Building, Washington.

Mr. Gharky has been identified with engineering, chiefly of an electrical nature, since his boyhood. He was connected with the Edison interests in the early days, and served successively with several concerns as an engineer. Among others he was with the Field Engineering Company, and later one of the engineering staff of the Philadelphia Traction Company. In 1897 he was Assistant Superintendent of lines and cables for the Union Traction Company, which controls over five hundred miles of line. He resigned this position to enter practice for himself.

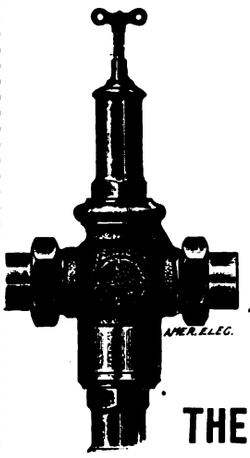
P & B INSULATING MATERIALS.—The letters P & B are so well known to electrical engineers and workmen that it seems almost useless to publish any information about the materials associated with them. But many engineers familiar with P & B compound may be surprised to learn how many varied materials the Standard Paint Company of New York City makes and lists under these two mascot letters. P & B ruberoid motor cloth for motor curtains, piazza decks, etc., is light, durable, odorless and clean to handle, contains no tar, and is water, acid and alkali proof. The P & B insulating tape contains nothing which will vulcanize under exposure to the weather or to heat and is water-proof, so that it loses none of its valuable properties when used in submerged or underground work, and the wires will not oxidize or corrode from contact with it. P & B armature and field coil varnish gives a hard, glossy surface which does not soften at any temperature up to 300 degrees. It is absolutely moisture-proof and has insulating properties which prevent it from cracking or flaking. Armatures insulated with it and P & B insulating paper are highly invulnerable. The Standard Paint Company also makes P & B preservative paint for coating the butts of poles, underground conduits and other surfaces which should be prevented from rot and decay. The company announces that the ruberoid cloth and insulating tape are meeting with an unusual demand this year.

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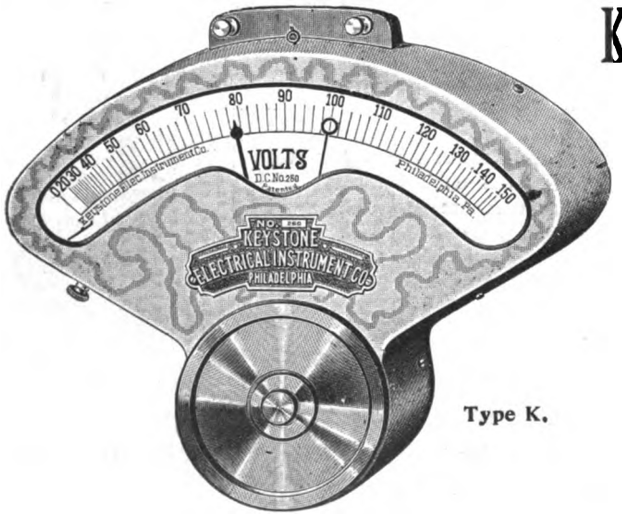
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For Generator Panels and High Grade Isolated Plants.

Notice the open scale at and near the point of normal working. The instrument is also most sensitive over this part of the scale. Can be calibrated for either direct or alternating currents of any frequency, or can be supplied with an inductive shunt, making one instrument interchangeable between direct and alternating circuits.

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# American Electrician.

Vol. XI. New York, August, 1899. No. 8.

## THE CENTRAL STATION OF THE LOUISVILLE ELECTRIC LIGHT COMPANY.

**A Description of a Comprehensive System Generating Alternating, 500-Volt Power And Series Arc Current.**

BY GEORGE WILBUR HUBLEY.

The Louisville Electric Light Company was organized during the year of 1883, with a capital stock of $100,000. Its first installation consisted of an arc lighting plant, having one 150 h. p. engine of the Corliss type, and six 20-light "United States" low-tension arc dynamos. During the year of 1892 the old Brush Electric Company of Louisville was absorbed and to-day, as the outcome of the original equipment, the plant is of such proportions as to represent an investment of about one million dollars.

The present officers of the company are: A. H. Barret, President and General Manager; Harry Bishop, Vice-President; and J. H. Gilbert, Secretary.

The present plant of the Louisville Electric Light Company, which was built during the years 1890-1891 by Drach and Thomas as architects, is located on Magazine Street, between Fourteenth and Fifteenth Streets, Louisville, Kentucky. It consists now of the original structure with an extension which has been required by the increasing business. The construction of this building is worthy of note, being strictly fire-proof and of iron girder and column arrangement such that the entire weight of the building and its contents is supported by the iron columns from foundations, the brickwork in no manner being called upon for strength or support, other than its own weight.

The main building proper is a three-story structure, one hundred and forty feet in length, sixty-five feet in width and sixty-five feet in height. To the east, adjoining this building, are the boiler room and coal storage rooms, which form a two-story structure of similar construction. On the north end of the main build-

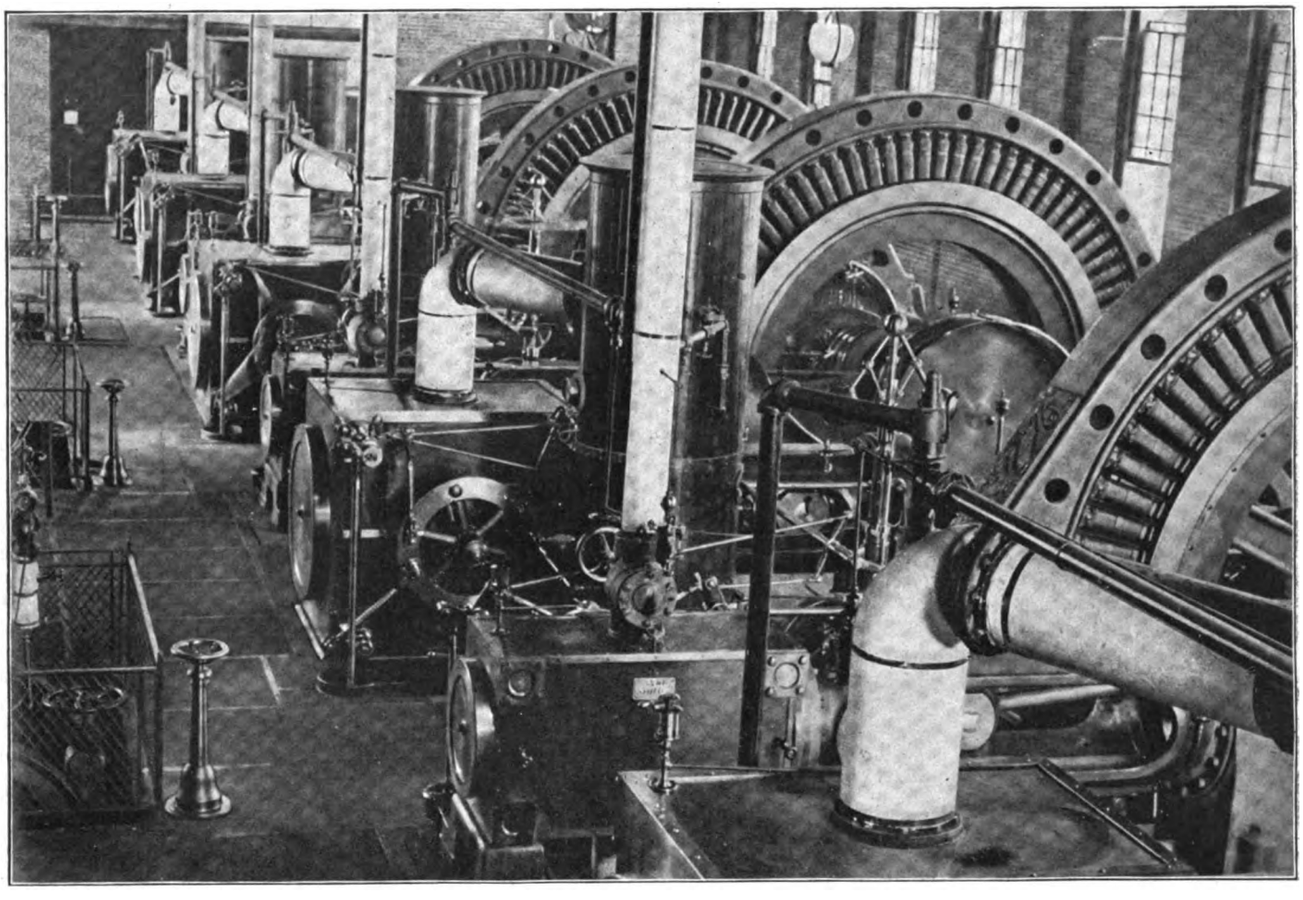


FIG. 1.—THE FOUR DIRECT COUPLED CORLISS ENGINES AND ALTERNATORS IN THE NEW ENGINE ROOM.

ing the extension of the plant adjoins, forming the addition used exclusively for direct-connected generators. This addition is constructed of similar materials as are used in the other buildings, with which its appearance harmonizes well. This new building measures one hundred and fifty-six feet in length and fifty-four feet in width, and the entire interior is

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one spacious room, open to the ridge pole of a trussed slate roof, which is sixty-two feet above the floor of the plant.

Although this station was constructed about eight years ago it can undoubtedly lay claim at the present day to being one of the most substantial and complete central stations in this country. In fact the solutions of the problems in its original construction, under the direction of Mr. A. H. Barret, by whom its main features were designed, give it a place among the first of modern central stations, as judged from an engineering standpoint.

The station has no architectural pretensions, being of plain brick and iron girders on masonry foundations. The most striking exterior feature is the immense octagonal brick chimney, two hundred and fifteen feet high, with a base twenty-two feet square, and an inside diameter of thirteen feet.

### THE COAL HANDLING EQUIPMENT AND BOILER DEPARTMENT.

The most important labor saving appendages to the station are the coal elevators and conveying apparatus. This apparatus, manufactured by the Jeffrey Manufacturing Company of Columbus, Ohio, was placed by Grainger and Company, of Louisville, Kentucky, and consists of four endless sprocket chains with buckets every third link, which hoist the coal from a pit below the level of the boiler room floor to a height of fifty feet, from which it is conveyed by endless belts to points convenient over coal hoppers feeding the boilers. These elevators and belts are driven by a 15-h. p. C. & C. 500-volt, direct-current motor, which is located in the dynamo room and there controlled, with an additional switch in its circuit placed in the boiler-room, to be used in case of emergency.

A fifth elevator, similar to those used for hoisting coal, is used for hoisting and loading ashes to car from basement. The weights of coal and ashes are carefully registered by large Fairbanks scales, and a daily record is kept of the same. The general arrangement of the coal handling equipment is most complete, and has proven in the service of the past eight years to be highly satisfactory in all respects.

Eight boilers of the water-tube Babcock and Wilcox type, with triple drums, are used. The normal rating is 300 h. p. each, on the basis of an evaporation of thirty pounds of water per horse power hour. The boilers are fitted with Roney stokers and furnaces and deliver gases to the chimney through a flue, lined with fire brick, which is eight feet six inches by seven feet six inches in section.

The boiler drums are covered with two inches of magnesia covering, and all steam and hot water pipes are also covered with similar material.

Fig. 3 shows a view from the south end of the boiler room, showing the railroad switch, the coal pits, the coal elevators and a portion of the boilers with their coal hoppers, stokers, etc. The stokers are at the present time operated by small Kriebel single-cylinder, vertical engines, but these are soon to be displaced by electric motors, which, for auxiliary work in the station, have proven more economical, reliable and satisfactory.

The coal used is nut and slack from mines in Eastern Kentucky, operated by the Central Coal and Iron Company, and is a grade averaging about 11,000 B. T. U. However, the economy with this coal has proven good, due to its use with mechanical stokers and a careful study of its combustion under the best conditions.

A special feature of the boiler department is the very complete system of purification of feed water. The water system of the station will be more fully described later on in this article, but the method adopted for purification of boiler feed water appeals for special mention. The "raw" water contains about fifty-four grains per gallon of foreign matter consisting principally of carbonates of calcium and magnesium, making its use for steam purposes prohibitive. Originally, three Hoppes live-steam purifiers of 1000 h. p. each were installed; and an additional system of water purification,

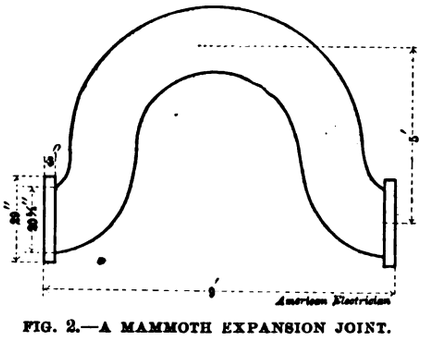



FIG. 2.—A MAMMOTH EXPANSION JOINT.

as manufactured by the We-Fu-Go Company, Cincinnati, Ohio, was added, and is used in conjunction with the Hoppes purifiers.

The following is a brief outline of the process of treatment by this combined apparatus: The raw water is pumped from the hot well, after having been used for condensing purposes, to a tank of 40,000 gallons capacity. It is then treated at its hot-well temperature (110° F.) by chemicals in a simple and practical manner. After the water is allowed to settle from four to six hours, it has been clarified and purified. From the tank it passes through an automatic valve into a gravity filter of quartz, and then is pumped by the boiler feed pump into the Hoppes purifiers, and thence by gravity feed supplies the boilers.

Fig. 6 shows a view of the We-Fu-Go purifying system. Two tanks are used, each of 40,000 gallons capacity, which give a total capacity of 160,000 gallons of water per day (allowing six hours for treatment and precipitation per tank). Two duplex steam-driven pumps, manufactured by the Gordon Steam Pump Company, Hamilton, Ohio, are used for water feed for boilers.

### ENGINE DEPARTMENT.

This department consists of two divisions, known as the new and old engine rooms, according to their priority; they are connected by an opening at the north end of the old engine room.

A 20-in. main steam line extends the full length along the eastern side of the old engine room and enters the addition, connecting with another line of the same size, extending the full length of the southern side of the new engine room. A duplicate 20-in. main steam line parallels the first line the full length of the old engine room, and this line is interconnected with the first line, and by means of valves provides against interruption in case of any accident or emergency that might arise, or in case of necessary repairs on steam lines. By such arrangement the main steam lines of the station are sub-divided into five independent sections that may be operated independently or collectively, as circumstances may dictate, thus giving great flexibility in the operation of the steam distributing system. These steam lines are supported about twenty feet above the level of the floor of the engine room by cast-iron columns from foundations in the basement.

Each boiler supplies steam at 160 lbs. per sq. in. pressure to the main steam line by an 8-in. steam pipe, connected into an angle valve placed in the engine room. All steam pipes and fittings are extra heavy and of special construction.

In the first main steam line is a hammered copper expansion joint of special construction, which is probably the largest expansion joint ever installed. A sketch of this expansion joint showing dimensions, etc., is shown in Fig. 2. This joint was constructed entirely of copper, hammered to a gauge thickness of one-fourth inch, and has a total weight of 1500 lbs. It was put through most severe tests previous to being placed, under guarantee to withstand such test conditions.

Each engine is connected with the main steam line by an 8-in. pipe, with its own valve in addition to the throttle valve at the engine. The entire system of high-pressure steam lines is relieved of all water from condensation by a complete system of "bleeders" that are connected with the Holly system, which returns this water at nearly boiler temperature to the boilers. The condensation of the low-pressure steam lines is trapped and drained to a receiver in the basement. An automatic valve, operated by the water level in this receiver, controls a small pump which pumps water at almost steam temperature back to the boilers.

All engines are operated condensing, and the supply of water for this purpose is approximately two million gallons per day. In a pump well, forty feet below the condensers, is installed a duplex condensing pump, made by the Gordon Steam Pump Company, and with a rated capacity of 2,500,000 gallons per day. The supply of water is obtained from a deep well adjacent to the pump well, and of the same depth. Thirty 8-in. tubes have been sunk to a depth of thirty feet below the level of the pump, or a total distance of seventy feet below the surface. The

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water is pumped to reservoirs of a total capacity of 150,000 gallons, which quantity is at all times maintained in reserve in case of emergency or breakdown.

Three 20-in. & 40-in.x48-in. 68 r. p. m. and one 12-in. & 24-in.x36-in. 78 r. p. m. Hamilton-Corliss tandem compound engines, manufactured by the Hooven-Owens-Rentschler Company, of Hamilton, Ohio, are employed in the old engine room. The three large engines are connected by three-ply 60-in. Munson belts, each to its respective line of jack shafting, located on the third floor of the building. The third line of jack shafting is divided into two sections by a main friction clutch coupling.

To one of these sections, from which the "all day" dynamos are operated, the small engine is connected by a two-ply 30-in. Munson belt to a special "quill" pulley.

These engines operate condensing, each having its own condenser and air pump, which is direct-connected to the engine. In addition to these three individual condensers these engines are each connected with one main condenser and pump, of ample capacity for the three, manufactured by the Dean Brothers Steam Pump Works, Indianapolis, Indiana. This main condenser is located in the basement under the old engine room and is provided for emergencies and the failure of the individual condensers.

The three lines of shafting are located on the third floor of the main building.

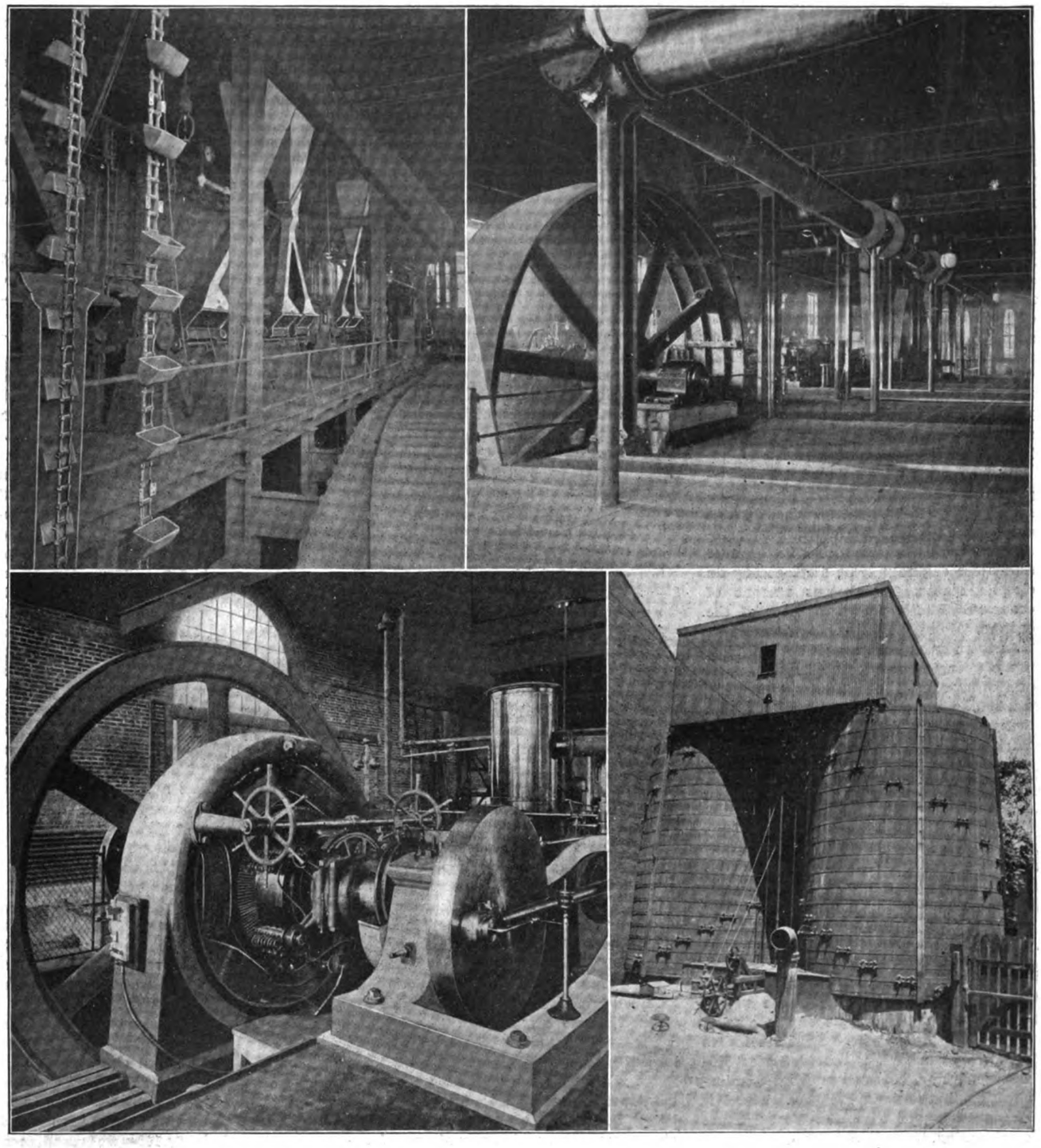


FIG. 3.—VIEW OF COAL ELEVATORS, ETC., IN BOILER ROOM.
FIG. 5.—THE 500 H. P. DIRECT CURRENT MACHINE.

FIG. 4.—VIEW OF OLD ENGINE ROOM.
FIG. 6.—THE WE-FU-GO WATER PURIFIERS.

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and directly over the old engine room. These countershafts are each fifty-four feet in length and seven inches in diameter, and are supported by eight large pillow block journal bearings. Each shaft is equipped with its engine pulley, with a 62-in. face and 48 ins. in diameter; also twelve pulleys, 52 ins. in diameter and 12½ ins. face, these small pulleys being loose on the shaft and controlled by friction clutches. The shafting and its equipment were manufactured by the Falls Rivet and Machine Company of Cuyahoga Falls, Ohio.

The lubrication of the shafting is accomplished by a system of gravity feed, the oil flowing through piping from a tank placed above the shafting. The oil, after passing through the bearings, etc., passes through pipes to a cistern on the first floor. From this cistern it is pumped constantly to the tank above. The oiling arrangements on the engines are such that oil used is drained to reservoirs, which at regular intervals are emptied into filters, and in this manner the same oil is used without much waste. The engine cylinders are lubricated by the use of Rochester lubricators, which have advantages over other methods, being positive in feed and economical in use of oil.

In the southwest corner of the old engine room is a Crane elevator of six thousand pounds load capacity, used exclusively for freight. This elevator at present is operated by steam, but in the near future the engine will be displaced by an electric motor, for obvious reasons of economy. Fig. 4 shows a view of the eastern side of the old engine room.

As the new engine room is entered from the old engine room, the impression is one of awe, and the contrast is most marked. Here the massive engines, with their direct-connected generators, plainly mark an epoch in electrical engineering, as relates to design and construction of the central station.

Near the entrance is the McIntosh and Seymour vertical cross-compound engine, 18 ins. and 36 ins. by 36 ins., speed 100 r. p. m. On its shaft, direct-connected, is a General Electric 400-kw, 500-volt, direct-current generator. Immediately facing this machine to the north is an Allis-Corliss horizontal cross-compound engine, to which is direct connected a Westinghouse 400-kw., 500-volt d. c. generator. These machines are used for the supply of 500-volt power service of the station during the day. The all-night service is supplied by a 75-kw. United States 500-volt generator, belt driven from countershafting in the main building. Fig. 5 is an engraving of the Allis-Westinghouse combination.

In line with this Allis engine are four Allis-Corliss cross-compound horizontal engines, each direct connected with a 500-kw. Westinghouse alternator. These machines supply single-phase alternating current at 2200 volts, primary potential.

As these four engines with their alternators are exactly alike, the description of a single unit will suffice for all. The engines are each astride of their generators—that is, the low-pressure cylinder, guides and crank shaft are on the collector or commutator side of the generator, and the high-pressure cylinder, etc., are on the other side. This arrangement eases the bearings, avoids flexural strains on the shaft and tends to smooth and easy operation. Steam is supplied to the high-pressure cylinder of these engines through 8-in. steam pipes connected to heavy 20-in. mains running the full length of this room, as previously described. Each engine has its own independent steam-driven air pump and condenser of Reynold's vertical type. For the common overflow a 16-in. cast-iron hub pipe is laid beneath the cellar floor, opening into the hot well in the basement.

For handling the large and heavy apparatus described is a ten-ton Phoenix traveling crane, which permits of the convenient and ready handling of apparatus during necessary repair work, or for the purpose of erecting or dismounting. The floors of the engine rooms are of cast-iron plates set on iron girders, which present a clean and neat appearance, embodied with great strength, as well as being convenient for access below or around machinery.

The engraving, Fig. 7, shows a general view of the interior of the new engine room, taken from the west end of the building, and Fig. 1 shows a similar view, taken from the eastern end of the building, in which the details of these engine-generator units are more clearly defined.

### DYNAMO DEPARTMENT.

The dynamo department occupies the entire second floor of the main building. However, this room properly should be termed the arc department, as it is now used almost exclusively for the arc dynamos, switchboards, etc.

Two Westinghouse multipolar 250-volt d. c. exciters are provided for the excitation of the alternators; however, one of these is of ample capacity to take care of all four alternators, and the second one is provided for emergency or in case of accident. These machines are belt driven from jack shafts and their location is so arranged that one operates from the shaft used for "day service" load, and the other one from shaft used for "night service" load. This arrangement furnishes two distinct sources of power, and admits of load being relieved from time to time between the two exciters.

The switchboard for the alternators is located in the northwest corner of the dynamo room, and is quite elaborate in its construction. A special feature of this board is the double-throw, double-pole circuit switches, which are of special design, with magnetic "blow-outs," for instantaneous breaking and "change over" of circuits. The arrangement of all "live" and moving parts of this high-tension board is such as to have them back of the board, and on the face of the board appear only the face plates, plugs and handles necessary for their control. Flexible cables and plugs are used for connections of circuits to generators. All danger is eliminated, and control of operation is facilitated by these systematic arrangements.

The engraving, Fig. 8, gives a view of this switchboard before it was placed in regular service.

The power switchboard is located in the center of the west side of the dynamo room, and is constructed of "Vermont" marble, supported by iron frame. This switchboard is employed in the control of the 500-volt and the 220-volt circuits, of which there are five of the former and three of the latter. The three 500-volt generators described are connected to bus bars on this board, and the 220-volt circuits are supplied with current from two Westinghouse multipolar dynamos of the "Kodak" type.

Twenty 80-light and one 125-light Wood arc dynamos and three 65-light Brush arc dynamos comprise the arc lighting equipment of this station. These dynamos, aggregating a total capacity of 1920 arc lamps of nominally 2000 c. p. each, are operated at a constant current of 9.6 amperes. The arc dynamos are each belt connected with a loose pulley, controlled by friction clutch on line of jack shafting. Each machine is independently controlled by means of lever arm extensions from the friction clutch of its "driver" pulley. Each of these pulleys is also provided with a braking device, controlled from the dynamo room by an extended lever arm. This device was specially designed for this station, and insures positiveness and quick action in stopping of the pulley and its dynamo, when necessary.

The arc switchboard is located in the center of the south end of the dynamo room. An interesting feature of this switchboard is the testing appliances, which are of the company's special design. These consist of a recording voltmeter, calibrated so that a reading as high as 6500 volts may be registered, and a recording ammeter registering continuously the current on the circuit. This ammeter and voltmeter are connected by means of plugs and flexible cables into the circuit, and a continuous record of volts and amperes is registered on a chart. The "Bristol" instruments are used in this application. These daily records on charts are kept on file. The practical value of these arrangements are obvious.

In addition there are for testing purposes plugs for connection of magnetos to indicate open or closed circuits on lines, by means of which hourly records of condition of lines are obtained. Also, a plug connection is provided to a lamp board, consisting of eighty 100-volt incandescent lamps in series, for testing and indicating grounds on circuits. By such method the extent and approximate location of a ground can be ascertained.

The eighty 100-volt incandescent lamps in series are so connected with an 80-point sliding contact switch that all or any number of the lamps may be thrown "in series" across the circuit to be tested. In

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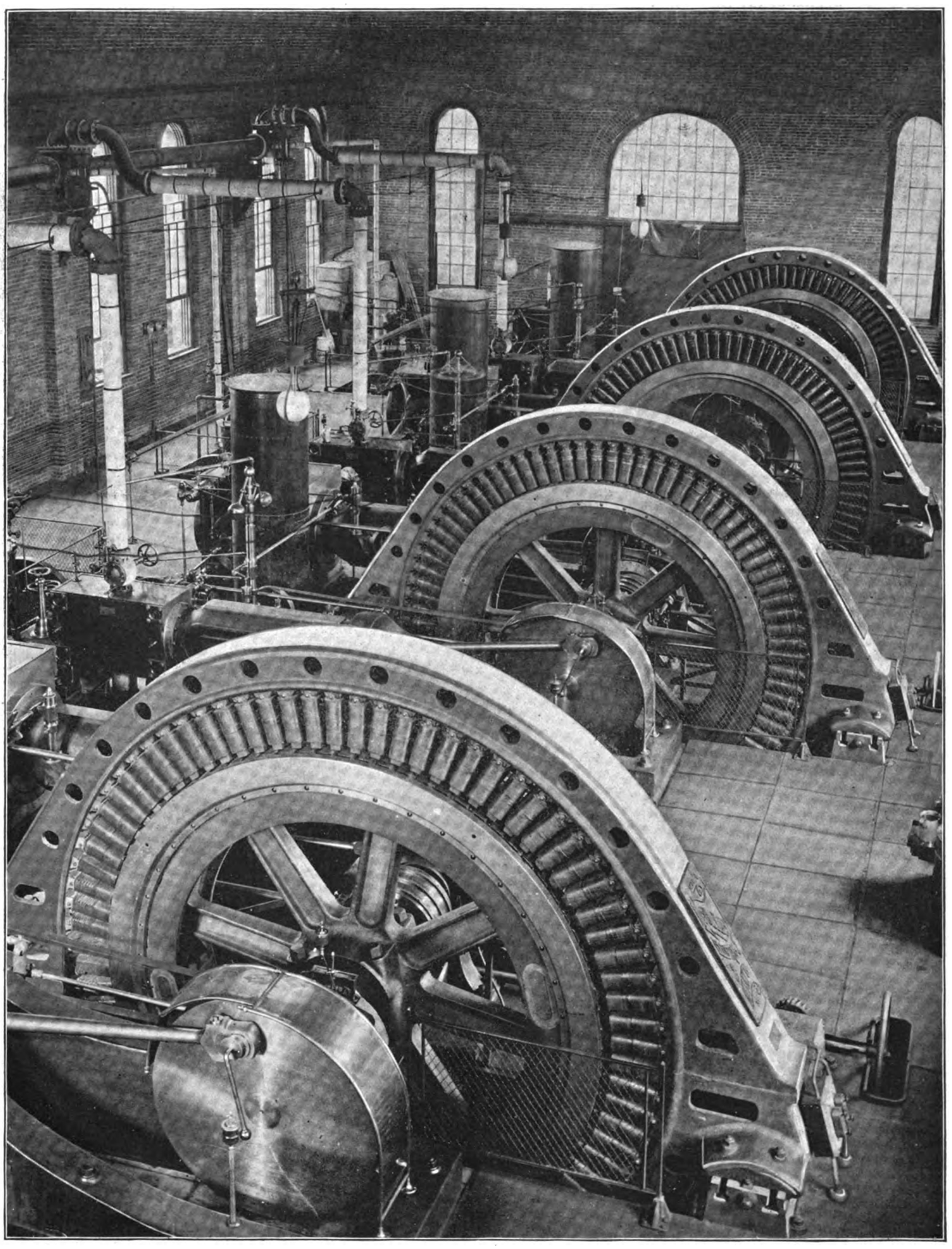


FIG. 7.—A VIEW OF THE NEW ENGINE ROOM, SHOWING THE FOUR ALTERNATORS DIRECT COUPLED TO CORLISS ENGINES.

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the use of this lamp board for testing of grounds, one terminal of the lamp board is connected to ground and the other terminal to the side of the arc circuit that is grounded, with all 80 lamps in series. Then the switch of lamp board is turned gradually, cutting out lamps in test board until the remaining lamps are brought up to candle power, 100 volts per lamp; then the product of number of lamps burning on test board by 100 volts indicates the total voltage of ground, and consequently its relative location from station.

Fig. 9 gives a partial view of the arc department, taken from an elevation in the southeast corner of the room.

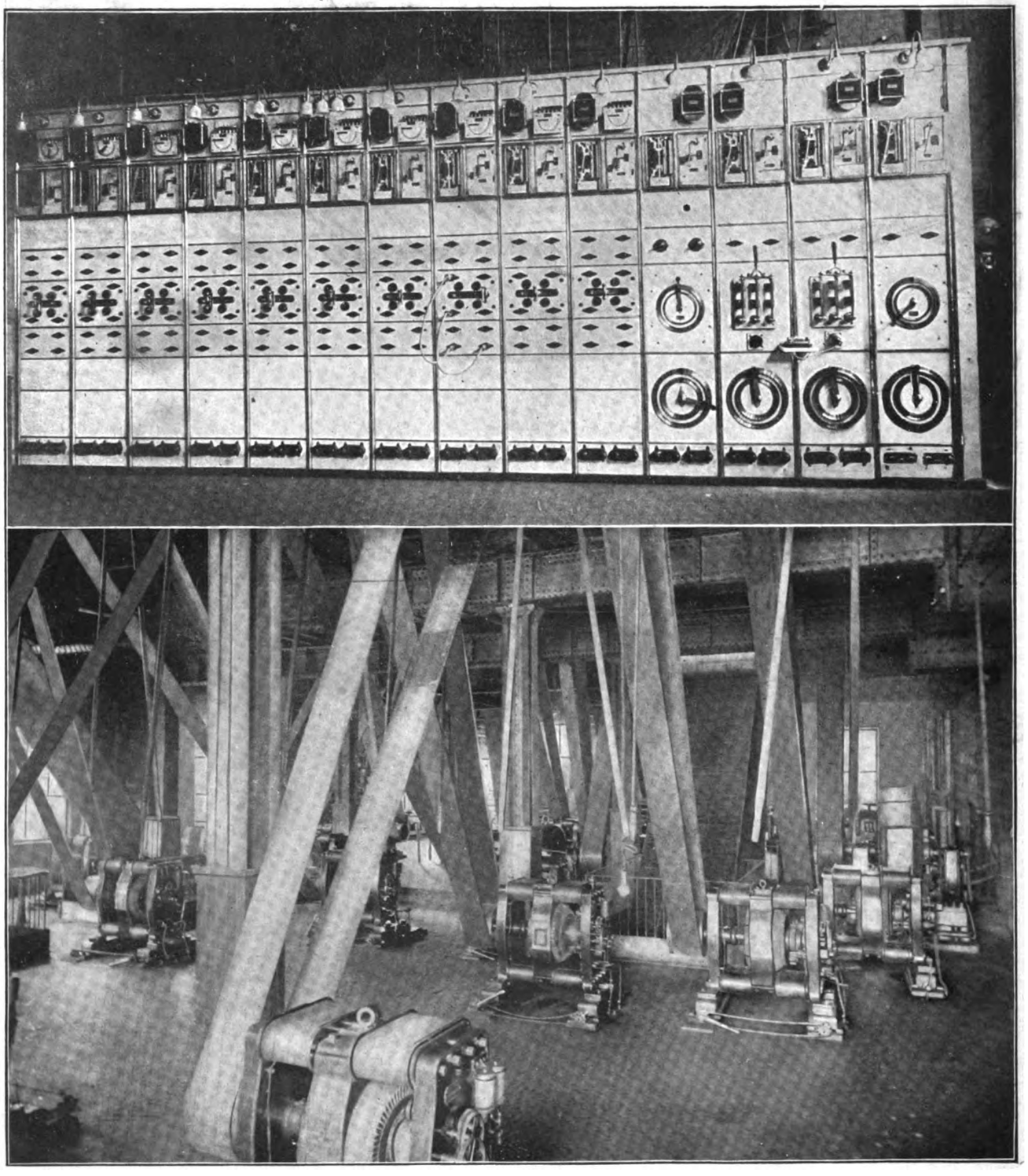


FIG. 8.—THE SWITCHBOARD OF THE ALTERNATING GENERATOR.
FIG. 9.—THE ARC DYNAMOS BELTED TO COUNTERSHAFT ON FLOOR ABOVE.

For cleaning and blowing out the dust, etc., from dynamos and other apparatus, an air blast with a pressure of 20 lbs. per sq. in. is used. This air pressure is maintained in a receiver, erected for the purpose, by means of a Crane automatic air pump. This receiver is connected by piping to convenient points in various departments of the station, and such arrangement greatly facilitates and insures thoroughness in this essential work. A whistle used for signaling purposes between the engine and dynamo departments is also operated by this air pressure, and its further application will probably be made in blowing tubes in boilers,

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although under the present practice, steam is employed for this purpose.

REPAIR AND TESTING DEPARTMENT.

On the third floor of the main building are located the repair and testing rooms of the station. These departments have had special and most careful attention, and have developed into much importance by the economies derived therefrom. Such work is conducted directly under the personal supervision of the superintendent.

All repair work of the station, as well as reconstruction work, is most efficiently handled. The combination of repairs and testing, under a complete system, has resulted in many improvements being adopted, and consequent reduction in cost of operation as well as maintenance. General repairs are made on armatures, transformers, arc lamps, meters, etc. Under the systematic plan adopted, periodical attention is given to these details, and a general inspection, cleaning, reassembling and testing complete is made at regular intervals on all apparatus employed, thus accomplishing the desired condition of maintaining apparatus up to a standard, and having records of its exact condition.

The testing department is a special and important feature of the station, being designed in view of practicability and simplicity. The testing work of the station is done with much facility, being reduced to a mechanical basis of work. Currents for testing purposes as high as 10,000 volts and 1000 amperes can be readily obtained. All apparatus, details and supplies employed in the station work are tested under requirements as set forth in specifications. Some years ago this station adopted this policy in purchasing new apparatus and supplies. All testing is conducted in this department with the exception of incandescent lamp tests, which are made at the general offices of the company, where a standard Bunsen photometer is located.

The pressure of 10,000 volts and currents of 1000 amperes mentioned are obtained by transformers from alternating lines; however, the station also is equipped with direct current for testing purposes within limits of 550 volts e. m. f. and 750 amperes current, and in handling such currents water rheostats are employed, as well as a novel and specially constructed resistance board consisting of 432 ½-in.x12-in. carbons.

The carbons are arranged in horizontal rows of nine carbons to each row and forty-eight rows. The connections between carbons are made by lead terminals moulded on each end of carbon, and the various rows are connected in multiple or series as desired by flexible cables to bus bars running vertical on the resistance rack. Each carbon has resistance of .11 ohms, making a total resistance when all are connected in series of 47.52 ohms. By the various combinations that can be made in connection on this improvised testing rack, it has proven a most convenient and valuable adjunct in testing department. The carbon resistance will withstand extremely high temperature, and another advantage is its low temperature coefficient.

STOREROOMS, OFFICE, ETC.

The balance of the space on the third floor of the station is occupied by store rooms and the superintendent's office.

The station office fills a position of importance in the plant, and emanating from this department the complete control of the comprehensive system described is maintained. Recording instruments of various kinds for registering pressure of steam, amperes and volts on various circuits are employed, furnishing daily registered actual records of the station operation. These are carefully preserved, in addition to the compiled data carefully and systematically recorded and filed from day to day.

DISTRIBUTION SYSTEM.

The overhead distributing system is of a high standard of excellence in its construction, insulation and general appearance. Some conception of its magnitude may be appreciated by the brief statement that this distribution system employs in main feeder lines a total length of about 400 miles of copper wire, the alternating service using about 50 miles of No. 00 and No. 0000, power service about 70 miles of No. 00 and No. 0000 feeders, and the arc service about 280 miles of No. 4 lines.

Many special features in details of line construction, arc lamp suspension and banking of transformers are of interest, but lack of space prevents detailed descriptions of these points. The high standard of construction and maintenance of lines attest the capabilities of Mr. W. O. Smith, under whose direction and charge this important work is conducted.

In conclusion, apologies are made for some of the engravings illustrating this article, owing to the photographs having been taken at the time of reconstruction, when much temporary work existed, detracting from the appearance which the station presents at the present day.

# Electrical Installation in Coal Mines.

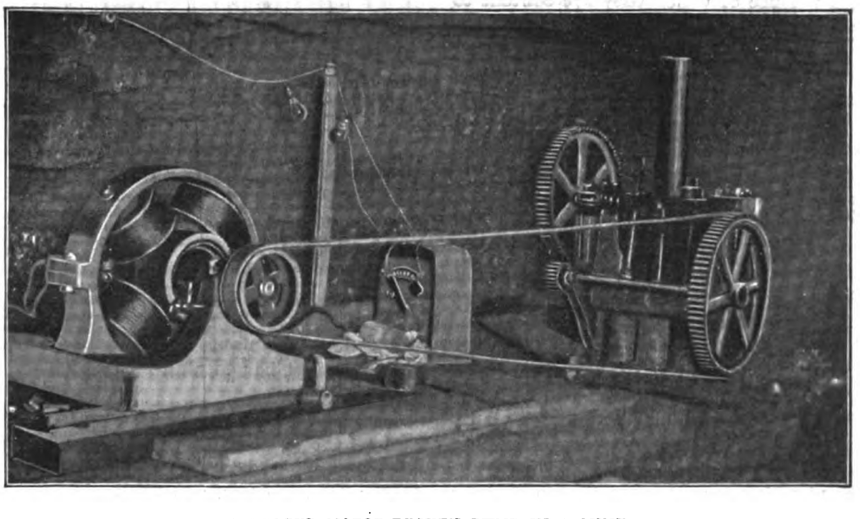
BY HARRY N. GARDNER

It is doubtful if in any branch of electrical application more complex problems have confronted the engineer than in that of work in mines, especially in the coal fields. Particularly can this be said of the anthracite region of Pennsylvania.

These problems, much more than those of many others applying to industrial electrical engineering, have presented conditions difficult of solution, influenced by commercial antipathies, ignorance and prejudice, and hostility of labor interests. And the strictly engineering questions that have had to be solved have been more numerous than in almost any other one field. In many ways they combine the conditions met with in the use of electrical power in mills, electric lighting and electrical railroading; and in this age of specializing each of these fields has already presented enough questions to demand its specialists.

The advantages of the use of electricity in various ways in coal mining are as certain as in any of the other larger fields; only the proportionate saving is not so great, the advantages are less marked and the prejudices to overcome have been greater.

With the adoption of electricity on street railroads about the only class of individuals to be injured was the horse raisers, particularly on the vast Western ranges. And it was not until electric cars were whizzing through the streets of most American cities, and they suddenly found that there was no market for their thousands of horses, that the horse raisers re-



A BELTED MOTOR-DRIVEN PUMP IN A MINE.

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alized their danger; and it was then too late to even try to stop the advance of the new power.

Many farmers in the middle west engage in raising mules for mine use, and there are mule dealers who buy the animals of the raisers and sell them to the mine owners. These men, strange as it may seem, have undoubtedly succeeded in doing much to impede the introduction of electricity into the mines. Some of these dealers have made fortunes in this line of trading, and are closely related to leading coal operators or superintendents of company mines, and their influence in preventing the advance of an improvement that would ruin their business has been greater than might be supposed.

Another thing that has deterred many individual operators from installing electrical plants is the large first cost. During the past six years the individual coal operators have been so held down by the transportation companies that their profits have been less than they desired. And it is difficult to persuade a man to install a $10,000 plant, partially as an experiment, at a time when his profits are falling off.

The conditions vary greatly and it is certain that in some mines a great saving could be affected by the introduction of electricity, while in others small economy would result. Inasmuch as the success of electrical operation has not been as great in some mines as was anticipated, all mine owners are slower to take advantage of the improvement than they would otherwise have been.

Again, the operators who have found a substantial saving in this method of operation are loath to give out information concerning the cost. And should inquiries be made, they strive to disparage the system the use of which they are content to continue.

Many of the mines are operated by steam railroad companies, and there is a natural feeling of hostility to electric traction on the part of managers of these companies that has had its influence in retarding the introduction of electricity into the mines.

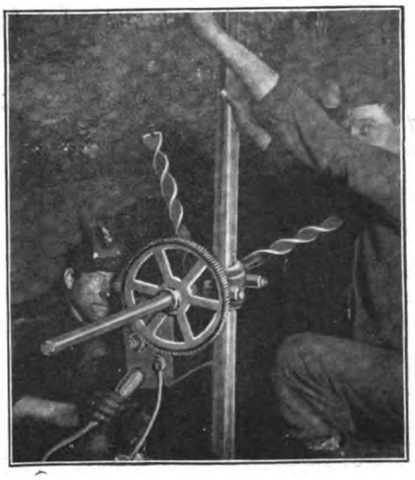
Each of these causes is small in itself; but taken in the aggregate, they have exerted an influence felt to such an extent that at present only about twenty-five out of several hundred mines in the Carbondale, Scranton and Wyoming districts have electric plants to assist in their operation. The fact that more operators than ever are now figuring on such plants and that companies with several mines, where sample plants have been installed, are planning for others, seems to promise well for this branch of the electrical industry.

From the strictly engineering standpoint, one of the first questions presented in this branch of work is to design special machinery that will be of use and stand abuse; for in hardly any other place is electrical machinery subjected to harder usage than in mining work.

The generator, particularly where electrical haulage is used, must be so designed that it will stand all manner of sudden changes from no load to a heavy overload. The dancing of an ammeter needle in a railroad power house is slight compared to one in a mining plant, particularly if two locomotives are used, and the dynamo is run from no load to a heavy overload and back again in a few seconds.

Fuel for steam generation for mine work is considered to cost nothing, so that economy in steam generation is the last thing thought of. And the steam traps of boilers and engines that are operated in many places are enough to bankrupt any firm that had to pay for coal. The unwritten law of mine operation is founded on dirt. It is impossible to keep anything clean around a mine or coal breaker; and no operator would consider the wheels of his industry properly moving unless they were hidden in coal dust.

The first thing that the electrical engineer has to figure on is the location of his generating plant. Some mine owners, who will pay $3,000 a year for board and



A MOTOR-DRIVEN DRILL.

a suite of rooms at a fashionable hotel, or $50,000 for election to Congress, will hesitate about putting up a $200 wooden building for an electric power house, trying instead to locate the plant in a dirty corner of the boiler room or shaft house, and run it from the old unsteady engines already in use. A building or room for the generating plant being secured, the engineer next has to plan on the voltage to be used.

In mines where electric haulage is used mules have to assist by bringing out cars form the chambers to the main gangways. Most mines are low, and the mules, men and boys are liable to come in contact with the trolley wire. For this reason, if the distance will permit, most engineers prefer a 220 or 300-volt plant. Should the increased cost of copper for a long transmission line make it necessary, a 500-volt current is used.

Strange as it may seem, however, about as many mules have been killed on circuits operated at 220 as at 500 volts. One case of such electrocution on a 220-volt circuit in a Carbondale mine afforded much satisfaction to the mine employees, if not to the owners. A particularly vicious mule had a habit, when mad, of biting whatever she could get hold of. If a man or boy was not handy, she would seize anything else. One day, while the driver boy was whipping her, the only thing that she could reach to bite was the trolley wire over her head. She seized that, settled back on her haunches, and without being able to spit out her mouthful, slowly burned to death.

When the "juice" is first turned into a mine, the employees usually give it a wide berth. The feeling of fear soon passes off, however, and the men get so that they little mind an occasional shaking up, even from a 500-volt circuit. In mines where 220 volts are used, the driver boys soon find a peculiar use for the current. A piece of wire, insulated for handling, but bared at the ends, and with one end bent so that it can be hooked over the trolley wire, makes a good substitute for the cruel "blacksnakes" which they unmercifully apply for accelerating mule speed. The manual labor of pricking up a mule with the end of the wire is less than by wielding the whip, and the sport afforded is much greater.

The transmission line combines many of the problems of interior wiring and exterior line work. Running the line from the generating point to the head of the shaft or mouth of the slope is much the same as ordinary line work. But the lineman or wireman who has run 4-0 feeders around steam pipes and up an ordinary elevator shaft appreciates something of the work required to run such a line down a 300 or 400 foot shaft into a mine.

In this work frequently too little care is used in properly placing the lines, and the grounds from improper insulation detract from the later working of the system. It is usually possible to attach ordinary wooden brackets to the shaft timbers for supports, and the regular petticoat glass insulators are used.

As soon as the foot of the shaft is reached plans have to be made for running the wires along the sides or roof of a coal or rock tunnel, and this necessitates a large amount of drilling and plugging.

In all mines a gutter-like waterway is dug or blasted out at one side. The mules and men always walk in the middle or at the other side of the tunnel. It is accordingly customary to run the transmission line along the side or roof of the mine, directly over the waterway. The trolley wire is also suspended from the roof at the extreme corner over the waterway; and for this reason the trolley poles of mine locomotives are placed at one side.

Supports for the wires are fastened into the rock or coal every twenty-five or fifty feet, according to the contour of the mine walls and roof. Two holes are drilled for each wooden support, and different kinds of wooden and metallic plugs have been devised for fastening these blocks to the

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walls. Sometimes ordinary wooden plugs are used, and the blocks are screwed up with lag bolts. The more satisfactory method is by the use of a special split taper iron plug.

Either heavy porcelain or glass insulators are fastened to these supports for the feeder wires, and the trolley wire is fastened to the blocks by means of the ordinary bell insulator trolley support. The rails are bonded the same as for surface traction for the return current.

The motor of a mine locomotive has to be constructed to stand even more heavy use and abuse than the ordinary street car motor. There is always much moisture in a mine, and the fine coal dust, everywhere encountered, is most penetrating, and is liable at all times to cause trouble to commutator or armature winding.

One work in which electricity has been found most efficient in the mines is for pump operation. It is much more easy to run a line of feeder wire than half a mile or a mile of steam piping; and the electric motor has been found a much more trusty operator of mine pumps than the small steam engines commonly employed, especially where the pump runs part of the time on air; and they perform their work with much less attention.

It is necessary to frequently change the location of pumps in mines. The pump and driving motor are accordingly mounted on a small car and by an easy change of feeder wires they can be drawn to any part of the mine and left to perform their work without attention. In a mine some time ago visited one of these small motors was found out near the end of the tunnel, far from the point where the nearest workman was employed. The only attention that it received was a monthly oiling.

Electric lighting has been employed in many mines to light certain parts of the main tunnels. The lamps are run in series, the number in a series depending on the voltage employed. The safety of electric lighting over the ordinary miner's lamp, for mines where fire damp is encountered, has been urged; but the method has been little employed for general mine lighting.

Electric drills have been found to greatly reduce the cost of driving tunnels in mines where it is necessary to remove much rock, as is frequently the case. For drilling in coal, a hole can be driven by hand nearly as fast as it is possible to move and set up the drill, either method requiring the services of two men. The drill motor has to be entirely encased in iron, and made so that it can be dragged over rocks and mud in the most careless manner.

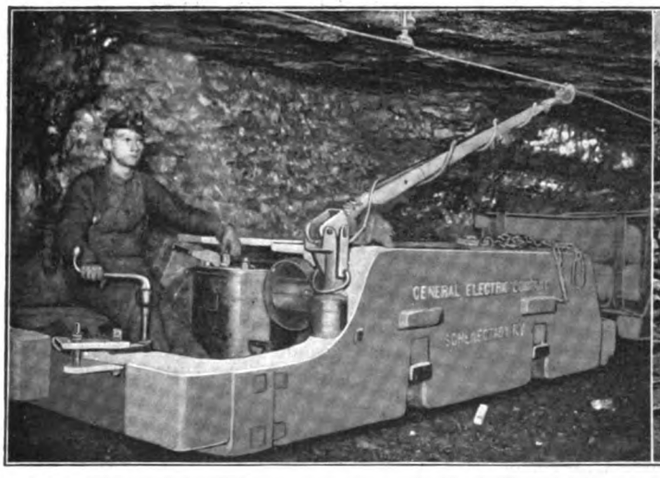
Even with the protected motors employed for all kinds of mine work, it is easy for employees, who are opposed to this system, to produce accidents with a frequency that has a discouraging influence on the introduction into mines of this power. Mine employees have looked upon the introduction of electricity into mines with much suspicion, fearing that it means the reduction of the working force. It is to electric drills, where used for rock work, that the most objection is made. And it is these machines that are the most liable to develop faults. Two men with such a drill can sometimes do the work of six men by the old method. And it is easy for a drill motor to be burned out, the drill broken or bent, or some other accident happen to the implement that will incapacitate it for service.

One cause that has helped to keep electric mine service from being as efficient as it would otherwise be is the management to which such plants are subjected after being installed. It frequently happens that a young man, who has had just enough experienec as a helper to cause him to call himself an "electrician," is employed to take charge of the electric plant. He is employed because he will work for $40 or $50 a month, when a competent man would cost $60 or $75; and he is expected to attend to the running of the dynamo and make all repairs to the machinery or lines.

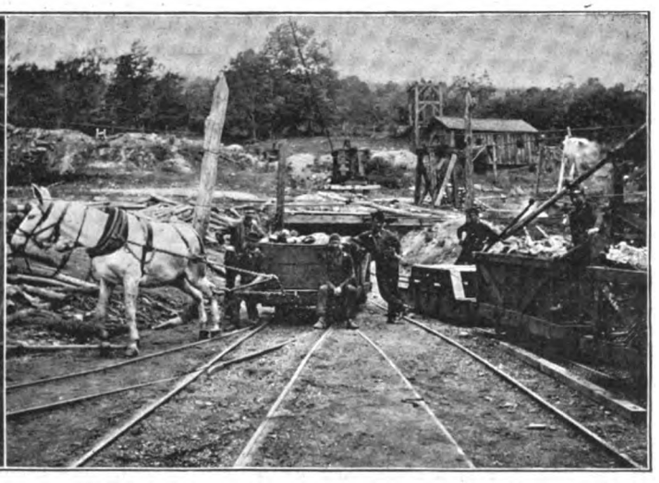
The work of one such "electrician" in a mine in the Lackawanna valley will illustrate the practical working of such economy. It had been necessary to make some changes to the circuits in the mines. There were frequent breaks to the wires, caused either through accident or intent of prejudiced laborers. Wherever it was necessary to make a splice, this "electrician" found it was much easier to make a "flying" one by simply bending the ends of the wires and hooking them together. In a few months these "flying connections" in the feeders were numerous. The pressure used was 220 volts, and the end of the tunnel was some distance from the foot of the shaft, so that the increased resistance of these poor connections resulted in a large voltage drop, and it was impossible to make the locomotive draw as many cars as it should. The attempt to draw a full load necessitated the use of so much current, at the reduced pressure, that the locomotive armature was burned out.

This "electrician" had secured the position on the representation that he could rewind any of the small armatures that might be burned out. Before his services were dispensed with he started to make such repairs, with the result that his successor found three dismantled small motors, the armatures of which he had tried to wind without success.

The employment of a competent man as electrician of this plant soon demonstrated that it was not the fault of electricity itself that had caused the mine owners to look upon the system almost as a failure.



A MINING LOCOMOTIVE.



HORSE AND ELECTRIC TRACTION.

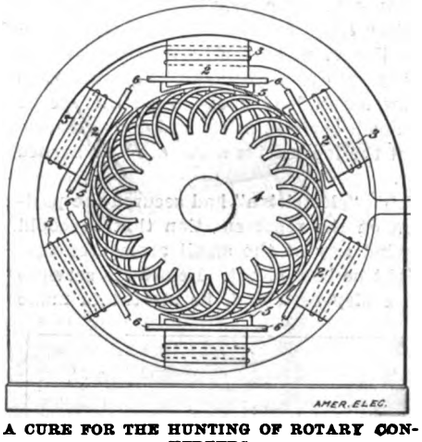
## Automobiles for Mail Collection.

The Postmaster of Buffalo, N. Y., has experimented with a borrowed automobile trap in the collection of mails from letter boxes. One route 18 miles in length with 40 boxes was covered with the automobile in 1 hour and 30 minutes, the same road with a horse and wagon requiring more than 3 hours. Other tests made July 2d and 4th showed a similar reduction of the time of collection. A specially designed automobile fitted with a box for receiving the mails has been ordered and will be put into service as soon as received and complete tests made with it.

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# Some Recent Electrical Patents.

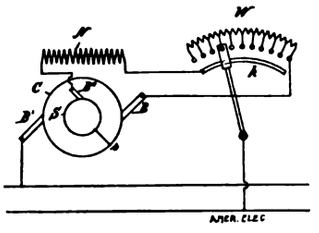
**A Cure for the Hunting of Rotary Converters.**—One of the most troublesome actions of alternating-current synchronous motors, and particularly of rotary converters, especially on systems supplied with power from steam engines, is the so-called "pumping." This consists of an oscillation of the armature superposed



A CURE FOR THE HUNTING OF ROTARY CONVERTERS.

upon its continuous rotation, that is to say, at one instant the armature speeds up and at another slows down, the action at times becoming so violent that the machine breaks out of step or synchronism with the system. A machine running alone never pumps, but two machines are likely to pump together, one speeding up as the other slows down, and vice versa, especially if the two machines are of about the same size and are separated from each other electrically by transformers and a transmission line. It is found that the pumping is accompanied by a shifting of the lines of force across the faces of the field magnet poles. When the machine speeds up the magnetism travels forward to the leading horns of the field poles and when it slows down travels back to the following horns. Mr. B. G. Lamme has accordingly invented a device for reducing the pumping by checking this traveling of the lines of force, which device is now quite generally used on rotary converters made by the Westinghouse Electric & Manufacturing Company. The arrangement is shown in the accompanying diagram, in which the device proper is designated by the figure 5. It consists of a strap around the pole with a shoe or extension coming into the air gap under the horn of the pole piece and covering a part of the area across which the lines of force shift. These straps are cross-connected at the ends, forming short circuited coils, so that any shifting of the lines of force is dampened or checked by the generation of foucault currents in these straps. A recent French design for the same purpose goes further and slots or tunnels the whole pole face, inserting therein a regular squirrel cage winding such as is used in induction motors. Patent No. 626,172.

**A New Field Connection.**—Small direct current machines with high voltages, if shunt wound, require a very fine wire in their field coils which increases the cost of construction as well as the bulk of the coil, owing to the large amount of insulation, and owing to its delicacy renders the machine liable to injury. Prof. Adolf Sengel of the Electrotechnical Institute of Darmstadt has patented an extremely simple means of cutting in two the voltage applied to the shunt winding, thereby allowing its cross section to be doubled, its number of turns to be reduced 50 per cent. and its resistance to be reduced 75 per cent. Incidentally the improvement is a great advantage in the starting of shunt-wound motors. The invention consists in connecting one end of the shunt field windings as usual to one of the lines and the other to a single collector ring tapped in at any point to the armature winding. When the machine is running at full speed the field is thus subjected to a fluctuating electromotive force, its instantaneous value changing every revolution from the full e. m. f. across the terminals of the machine to zero and



A NEW FIELD CONNECTION.

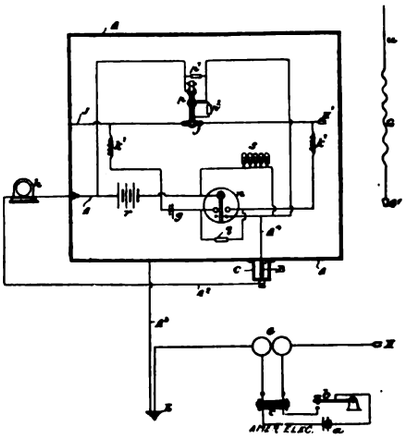
back again. The general arrangement of the apparatus is shown in the accompanying diagram in which N is the shunt field connected between the outside terminal of the armature rheostat W and the brush B′ bearing on the collector ring S, which is connected to the armature winding at the point s. Obviously when the resistance W is all cut out s will be in contact with B at one instant and with B′ at another instant. In the first case there will be no e. m. f. across the field windings and in the second case the full e. m. f. of the machine. This fluctuating e. m. f affects an inductive circuit, such as a field winding, as though it were a direct e. m. f. of half the full strength on which is superposed an alternating e. m. f. The latter will be choked back by the self induction of the field winding, while the former will magnetize it. In starting a shunt motor, while the machine is at low speed the fall of potential is mainly in the starting rheostat W, around which the field winding is obviously shunted. The field will thus get in starting double its normal e. m. f., which will gradually be reduced as the speed comes up, giving a considerable increase of the field strength in starting and a corresponding reduction of the number of amperes required to start a given load. For the brief time of starting the motor the field will easily stand this double current strength. Patent No. 624,986.

**The Marconi Patent on Wireless Telegraph Apparatus.**—A patent on the details for protecting the coherer from the fierce Hertz waves sent out from a transmitter at the same station has been granted to the now famous worker in wireless telegraphy, Mr. Guglielmo Marconi and assigned to the Wireless Telegraph & Signal Company, Ltd., of London. While the patent apparently has no value, as its claims are limited to combinations of many parts, some of which are unessential, still its drawings give some idea of the arrangement of Mr. Marconi's apparatus.

Referring to the accompanying diagram, u is the aerial wire connected through a flexible cord, G, with a plug, G′, which can be inserted in the spring clip, H, for transmitting, or in the spring clip, $H^1$, for receiving. In the former position it is connected to ground through the sparking balls, e, forming the terminals of the secondary of the induction coil, C, fitted with battery and key for transmission in the well known way.

The coherer, its tapper, relay, batteries, resistances and choking coils are all enclosed in an iron case, A, a suitable thickness for which is given as 1/20 of an inch. Through an opening in this case the connection from the aerial cord may be plugged, as mentioned above, connecting to the clip, $H^1$, and thence to the coherer, j, and through wire, J, to the iron case, which is grounded. Shunted around the coherer is the relay, n, with choking coils, $kk^1$, to prevent the oscillatory currents from passing through the relay winding.

A single cell battery, g, is connected in the circuit through the coherer and relay



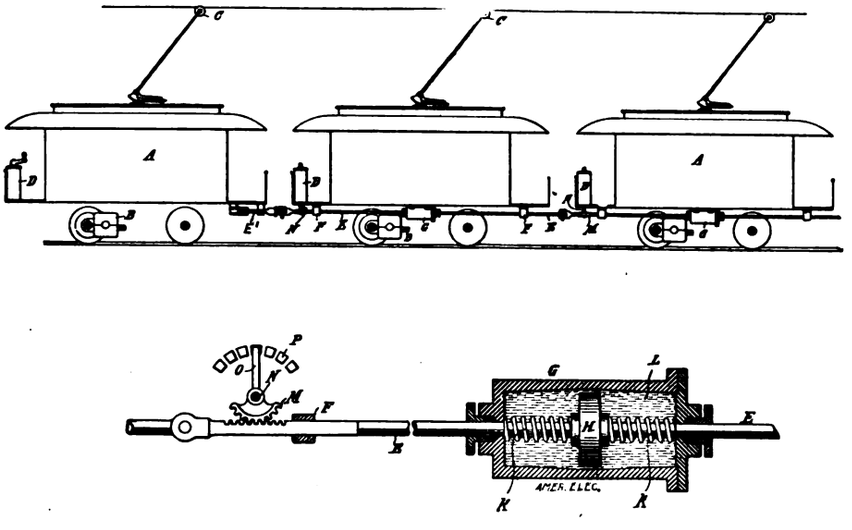
THE MARCONI PATENT ON WIRELESS TELEGRAPH APPARATUS.

coils. The contacts of the relay are connected to the battery, r, and thence up to the tapper, p, and through a ground on the enclosing case to the sounder, h, which is preferably located outside the case. The return wire from the sounder passes through the choking coil, B, which the patent states may contain about 20

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yds. of wire 1/75th of an inch in diameter and having 120 turns. The wire is covered with tin foil, which is connected with the iron box, the purpose of which is to prevent the oscillatory currents set up in the sounder circuit from entering and disturbing the apparatus inside. The contacts and coil of the tapper are shunted by resistances, $p^1p^2$, and the contacts of the relay are shunted by the resistance, s, to prevent sparking at these points, which might itself set up feeble waves which would affect the coherer in close proximity. Patent No. 624,516.

**A Simple Multiple Unit Controlling System.**—In the operation of electrically driven trains with motors on two or more of the cars it becomes necessary to install quite complicated apparatus for assuring the positive control of these various motors simultaneously from any desired point, usually the head of the train. Such systems have been designed, notably by Mr. F. J. Sprague, as well as by the engineers of the General Electric and



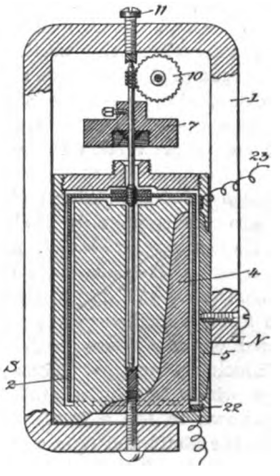


A SIMPLE MULTIPLE UNIT CONTROLLING SYSTEM.

Westinghouse companies. A very simple plan for making the draw bars of the cars themselves the means of transmitting the impulses has been patented by Mr. H. S. Maxim. As shown in the accompanying diagram, there is a sort of continuous draw bar, E, running through the train and attached to each car by means of a plunger, H, on the draw bar, driving, through springs, K K, the ends of the cylinder, G, attached to the car. The cylinder is also filled with a liquid to prevent sudden oscillations of the piston in the cylinder. The draw bar is also attached to the controlling mechanism by any means such that the movement of the piston from the mean position in the cylinder tends to start the motors in one direction or the other. The general scheme is that on starting the first or leading car in the ordinary way, the forward pull of the draw bar and the drag of the other cars upon it will cause their controller cylinders to be turned to such a point that current will be turned into their motors, tending to drive them with sufficient torque to prevent them from dragging with any considerable force from the leading car. Patent No. 625,454.

**An Alloy of Common Metals with the Coefficient of Expansion of Platinum.**—Since the price of platinum has risen to its present high value of about $18 per troy oz., it has become particularly worth while to discover other metals that will take its place. One of the greatest demands for platinum is the construction of such articles as incandescent lamps, where a metal must be incorporated with glass. The value of platinum for this purpose is due to the fact that its coefficient of expansion is the same as that of glass, and therefore when an incandescent lamp is heated both platinum and glass expand together, causing no breakage of the glass and no separation of one material from the other to allow air leakage. Hitherto no other satisfactory metal has been found for this purpose. C. E. Guillaume of Switzerland and L. C. Dumas of France claim in a recent patent to have discovered that alloys of nickel and steel expand and contract under variations of temperature in a peculiar way, differing from the manner of either metal separately. By varying the proportions an alloy may be obtained with any desired coefficient within certain limits. With small proportions of nickel the coefficient of expansion is between that of iron and that of nickel, rising as the proportion of nickel is increased, until, with 23 per cent. of nickel, it reaches its maximum, approximately that of brass. As the proportion of nickel is further increased the coefficient of expansion diminishes progressively until, when the nickel reaches about 37 per cent., it becomes practically nil. Beyond this proportion the coefficient increases progressively and becomes approximately equal to that of platinum when the amount of nickel used in the alloy is 45 per cent. The first claim of the patent reads: "An alloy of nickel and iron having the same coefficient of expansion as glass, substantially as described." Patent No. 626,655.

**A Direct Current Meter Motor with Mercury Commutation.**—For the metering of direct currents instruments of the motor type have practically driven from the field all other varieties of meters. They require, however, commutators, which are the source of their greatest troubles. The commutators must be practically frictionless and yet have sufficient pressure on the brushes to avoid open circuit or sparking in case dirt or dust accumulates. Mr. E. S. Halsey has patented a motor for this purpose in which the commutation is done by means of mercury, giving a fluid friction which is constant and negligible at low speeds, rising with the speed, thereby acting in part as a suitable brake. A further braking effect is obtained in the usual way by means of foucault currents, which are generated in the same conductor that carries the current, the same permanent magnet thereby giving the field for both the motor and brake. The meter has therefore no shunt circuit as has an integrating



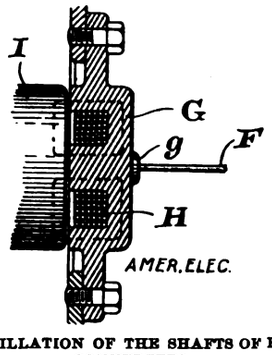
A DIRECT CURRENT METER MOTOR WITH MERCURY COMMUTATION.

wattmeter, but is an integrating ammeter. Its losses on open circuit are zero. The general design is shown in the accompanying vertical section, in which 1 is the magnet screwed at one end to the pole piece, 5, opposite the opposing pole piece, 4. Between these two runs the inverted cup of copper, 2, suspended on a shaft, 9, connected by a worm wheel with the usual train of gears, 10. The inverted cup runs in a chamber which is filled full of mercury for the purpose mentioned above, as well as for floating its weight, which it does so effectively that a counterweight, 7, must be added to prevent upward pressure against the upper bearing. The current is introduced at 22 and taken out at 23, flowing through the mercury and in large part, owing to its lower resistance, through the copper of the cup. This gives a turning movement to both the mercury and the copper, this moment being proportional to the current flowing, giving the parts a proper speed to integrate the load. Tests described and plot-

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ted in the patent specifications show a remarkable accuracy at low loads—a 25-ampere meter being only 1 per cent. slow with 1 ampere and 5 per cent. slow with ½ ampere. Patent No. 626,832.

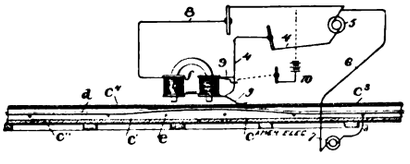
**The Oscillation of the Shafts of Rotary Converters.**—To avoid the grooving of commutators or collector rings on dynamo machines due to brushes constantly traveling in the same path over the face




THE OSCILLATION OF THE SHAFTS OF ROTARY CONVERTERS.

of the copper, it is customary to leave a little end play in the shaft and allow it to oscillate back and forth. In mechanically driven machines this oscillation is, as a rule, accomplished without any special apparatus, simply by the axial mechanical forces of the belt or connecting rods. In rotary converters the armature is likely to run without any endwise oscillation and the commutator and collector rings are correspondingly likely to develop bad grooves. Mr. E. W. Rice has patented a device for constantly oscillating the shafts of such machines axially back and forth, which device is now generally used on converters made by the General Electric Company. That part of the device which is attached to the machine is shown in the adjoining cut, in which I is the shaft and G is a cast-iron piece bolted to the frame of the journal. This is cored out to receive the coil shown at H, which, when energized, tends to magnetize the central core and draw toward it the end of the shaft I. This coil, H, is supplied with direct current through wire, F, from an interrupting device which repeatedly turns the current on and off at intervals of a few seconds. Every time the current is turned on the shaft, I, is drawn toward the magnet, and every time it is turned off the shaft is released and moves toward the left. The interrupting device in some installations consists of a commutator driven through a worm gear by a small induction motor. In other cases it consists of a magnet which pulls up a contact, breaking the circuit of the magnet, which then falls again against a dash pot. Patent No. 625,806.

**A Simple Sectional Conductor Railway System.**—One of the most fascinating devices for inventors in the sectional conductor railway field, is a switch under the road bed actuated by the field of force of a magnet carried by the car. A sort of continuous switch of this kind has been patented by Mr. H. Barringer Cox of thermo-electric battery fame. Referring to the adjoining diagram, $c^3$ is the top of the sealed conduit divided into sections insulated from each other by the spaces, $c^4$. Within this sealed conduit is the bare and live conductor or feeder d,



A SIMPLE SECTIONAL CONDUCTOR RAILWAY SYSTEM.

of iron or steel wire or cable, supported on the cross pins, e. The car carries a magnet f, which lifts this live cable into contact with the sectional top of the conduit from which the current is taken by means of the shoe. Unfortunately the invention does not appear to have been broadly patentable, as the claims are limited to the combination of many devices, some of which are unessential. Patent No. 624,304.

# Among our Foreign Contemporaries

**What to Do When a Dynamo Fails to Excite.**—In the case of a self-exciting dynamo which refuses to build up, a number of tests have to be made in order to locate the "trouble," and it is often necessary to make these in a hurry, for which reason it is advisable to make them in the right order. A list of these tests is given in a recent issue of the London Electrical Engineer, and they are briefly as follows: Make sure that the brushes are on the right place on the commutator, and, of course, see that the brushes really touch. Then see that they are set properly, relatively to one another; that is, if there are several sets of brushes see that the distances apart are equal; should the armature have a double winding, the brushes must, of course, cover more than one commutator strip at a time and they must, therefore, be of the proper thickness to do so. Then start the machine and run it at its proper speed; if this does not make it excite then find whether the shunt winding is really connected with the brushes, and if it is then try for ground leakage, which is especially important in the case of a shunt machine, for if the field is short circuited the dynamo will, of course, not excite at all. Then see if there is not a break in the field winding, a fault which is more likely to arise in shunt machines. In looking for possible ground connections it is, of course, desirable to disconnect the machine from the circuits, as one of the two faults may lie outside of the machine. If all this does not help, try changing the shunt connections at the brushes, for if they have been connected wrong it is evident that the machine cannot excite itself; also see to it that the field windings are so connected that they give the proper sequence of poles and are not both north or both south poles. If there are slight signs of a field it may help to connect the two halves of the shunt winding in parallel, if that is possible, as, for instance, if there are two coils to the magnet; this would increase the current in the field; but this, of course, applies only to shunt and not to series wound machines, as in the latter the parallel connection would reduce the ampere turns. Also see to it that the shunt and series windings, if it is a compound machine, are not opposing each other, for in the latter case the machine might run with a few lights but would lose its field as the load is put on. If all this fails to locate the trouble, the armature must be examined; to find short circuited coils in the armature excite the machine separately from some other source and note which sections become overheated. If this does not locate the trouble, then run the machine separately excited at the normal voltage and see if the armature has its normal output; if it has not, and the machine is a new one, there is something wrong with the armature. If this also fails to locate the difficulty the case may be considered a fairly hopeless one, and an expert should be called in.

**The Removal of Wool from Skins by Electricity.**—A process has recently been patented for the above purpose by a means invented by a lady living in Bradford, England. The instrument shown in Fig. 1 consists of an electric cautery

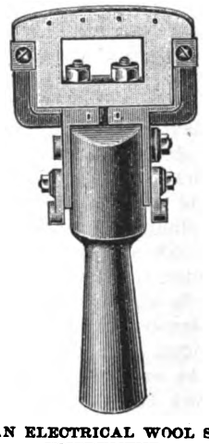


FIG. 1.—AN ELECTRICAL WOOL SHEARING INSTRUMENT.

knife, the cutting of the wool being accomplished by means of a platinum-iridium wire, rendered incandescent by an electric current of about 60 amperes at 4 volts. The red hot wire mows down the wool at a speed so great that the heat in

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no way injures either the skin or the wool. The process now in use consists of allowing the skin to decompose slightly, after which the wool is torn off by hand. A treatment with lime or other chemicals is sometimes used, but tends to deteriorate both the skin and wool.

**An Electrically Lighted Life Buoy.**—The English electrical papers describe a new form of electrically illuminated life buoy, the invention of a Captain Meller, now being introduced on the British market. The arrangement is shown in Fig. 2, which shows that it consists of a large cork ring of the usual type, provided with a lantern at the top of a tubular pole, the lower end of which is weighted with the accumulator, the latter being specially constructed for the peculiar conditions of continuous charge and very rare discharge. The pole between the accumulator and lantern is attached to the buoy through a universal joint which allows it to remain upright while the buoy floats on the waves. An automatic switch is

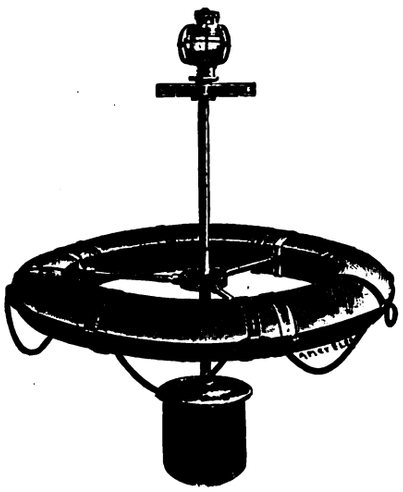


FIG. 2.—AN ELECTRICALLY LIGHTED LIFE BUOY.

provided, so that when the apparatus is out of use and on shipboard the light is turned off, but when the buoy assumes a horizontal position on the surface of the water the light is turned on.

**A Multiple Rate Meter.**—In a general article on the various systems of charging for electrical energy, Messrs. C. E. L. Brown and J. L. Routin describe in "L'Industrie Electrique" a system of their own, intended to go further than the two-rate system used to a certain extent in this country by establishing a large number of rates, increasing as the central station load rises to its daily peak and falling off as the load goes down again. The principle of the apparatus is shown in Fig. 3, in which r is a ratchet wheel driving the meter train, and actuated by the pawl, p. This pawl is attached through the rod, o, to the armature, m, of the magnet, f. One of these magnets is installed in each meter and all are connected between one side of the network and ground. By putting in a storage battery between the same side of the network and ground at the central station and making and breaking the circuit every few seconds the various magnets of the different meters are actuated in unison. The metering is done by the cam-shaped vane, v, which is turned toward the position, $v^1$, as the load increases. The amount by which

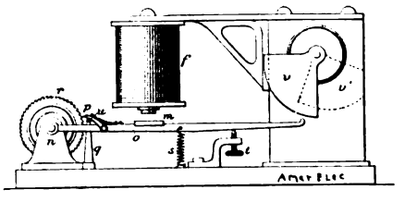


FIG. 3.—MECHANISM OF A MULTIPLE RATE METER.

the pawl can rise depends upon the clearance betwen the right hand end of the rod, o, and the vane, v, and this clearance depends upon the load at that instant. Thus if the magnet, f, is actuated at regular intervals the ratchet wheel, r, will be driven forward an amount dependent upon the position of v, and hence dependent upon the load. The multiple rate feature is introduced by varying the frequency of the impulses given to the magnet, f, by varying the frequency of the contacts to ground at the central station. At times when the load is heavy these contacts are made more frequently, while at times of light load they are comparatively infrequent. Thus the meter train is driven forward more rapidly with a given load upon the meter at any desired time of day than it is at others. The arrangement also contemplates the use of direct currents between the network and ground in case of alternating systems and alternating currents in the case of direct current systems, so that any accidental grounding or leakage on the other side of the system does not affect the apparatus. If an alternating current magnet is used

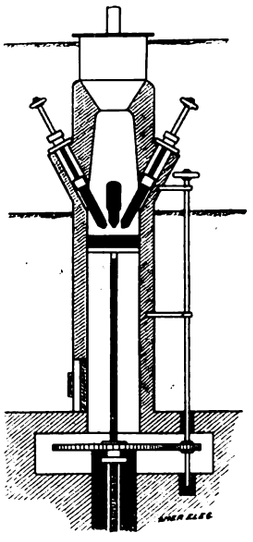


FIG. 4.—SECTION OF A THREE-PHASE FURNACE.

it is put in series with a condensor to shut out direct currents and if a direct current magnet is used it is made of very high self-induction to shut out alternating currents.

**Three-Phase Electric Furnaces.**—In a paper presented before l'Association des Ingenieurs Electriciens de l'Institut Electrotechnique Montefiore, at Liege, Belgium, by M. Segre, there was described a calcium carbide plant at St. Marcel d' Aoste, Italy, of interest because of the use of three-phase currents in each furnace. The general design of the furnaces adapted for these currents is indicated in the vertical section, Fig. 4, which shows the three main terminals of carbon inclined downwardly and inwardly toward a vertically movable carbon plate which may or may not be connected with the central or neutral point of the Y connected supply circuits. The furnace is intended for continuous operation, the position of the parts shown being that at starting, the materials being introduced in briquette form at the top, and the plate being lowered until the finished carbide can be removed piece by piece through a door shown on the lower left hand side, the furnace remaining meanwhile in continuous operation. Between the three main terminals there exist three arcs, or

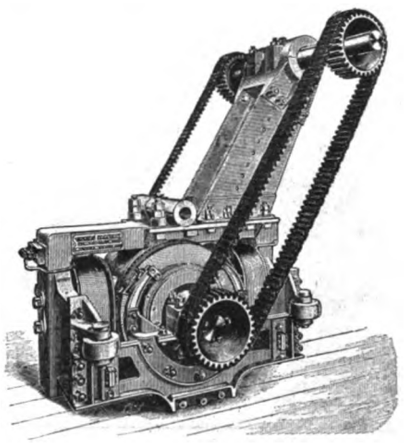


FIG. 5.—THE DRIVING MOTOR OF A BEHR MONORAIL CAR.

what might more properly be considered one rotary arc, which also spreads from these terminals to the conducting mass below. The furnaces are supplied with current at 16 cycles per second. In the paper mentioned many other interesting details were given, among them the preparation of the briquettes, wood charcoal being used to supply the carbon, and other peculiarities which the plant exhibited, a description of which would be too lengthy for these columns.

**Sprocket Chains on Motor-Driven Cars.**—The proposed Behr single-rail lightning express railway between Liverpool and Manchester, on which a speed of 100 miles an hour is to be used, will, if built, make use of electrical and mechanical details similar to those of the Behr railroad at the Brussels exhibition some years ago. An illustration of the motor and chain driving plan of the Brussels type of car is reproduced in Fig. 5, from the "Mechanical Engineer." The chain is of interest owing to the fact that contrary to prevalent ideas it gave very satisfactory

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service. The car as run in Brussels was driven by four 75-h. p. motors at a speed of 600 r. p. m., giving a chain speed of 2000 ft. per minute. The gear ratio was 1 to 1, and the chain was used in place of connecting rods for fear of the mechanical strains which would be introduced by the latter at high speeds. The chain width was 4 ins. and the cut shows that its arrangement differed from that of sprocket chains commonly used on bicycles in this regard—that the teeth of the sprocket wheels did not enter between the links of the chain, but the latter were U-shaped, fitting over teeth like those of spur gearing. The writer in the contemporary mentioned above stated that the chains were practically noiseless, no sound of working being heard, and if there was any noise it was completely drowned by the hum of the armature.

**A New Method of Assembling Accumulators.**—A new vertical arrangement of accumulator cells is described in the "Electrotechnische Zeitschrift" by A. Tribelhorn of Buenos Ayres, cells arranged

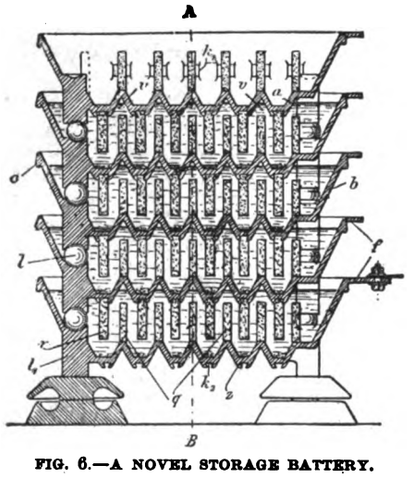



FIG. 6.—A NOVEL STORAGE BATTERY.

in this way being manufactured by Adolph Diener, Zurich. Referring to Fig. 6, the receptacle, $l_1$, is made of lead and has the form of a tray with a corrugated bottom, a. On the four corners are supports which hold the spherical insulators, l, These keep the trays separated, insulated from each other, and in a definite position. Larger trays have a greater number of supports and an extension, c, by means of which the trays can be lifted by a special tool. The strip electrodes, q and v, can be constructed in any known manner. They are attached to the upper and lower corrugations, a, of the bottom in such a way that the positive plate, v, hangs from the bottom and the negative one, q, stands in an upright position. The positive plate is usually fastened by means of dovetail joints, soldering or wedges, the negative one by means of side lugs. The electrodes are put in place in large cells at the place of erection. The trays may be coated with an acid proof paint, or the bottom may be made of sufficient thickness so that the decrease in capacity of the electrodes is compensated for by the increased capacity of the bottom of the trays. Batteries from 1 to 2 ft. in height have been constructed, giving from 30 to 60 volts. The area occupied by such a battery is only double the space taken up by a single accumulator of equal capacity of the old type.

As will be seen, the grooves, z, form canals in which the waste material may accumulate, while the upper grooves, v, serve to conduct away the gases.

The advantages claimed for the new method are as follows: The strip electrodes are more stable than large plates, which are more quickly deformed by the unequal density of the liquid, poor casting, etc. The separate jars being abolished, the insulation of the different cells becomes more certain. There are no soldered connections between the elements. The extraordinary saving in space. It may be claimed that the plates cannot be inspected easily. In answer to this it is claimed that there is no necessity for frequent inspection, as the danger from short circuits and buckling is considerably reduced. Specific gravity determination can be made with ease.

**A Novel Changeable Gear.**—An epicycle gear train, the ratio of which can be changed by tightening or loosening a friction clutch, was described in the "Mechanical Engineer," and has since been commented upon in French and German technical papers. It was designed originally for the back gearing of lathes, but has been found useful in connection with single-phase motors, to one of which it is shown attached in Fig. 7. It should also be a valuable device in automobile work, since the gear ratio can be changed while running and without changing over the teeth of a pinion from mesh with one gear to that of another, which operation

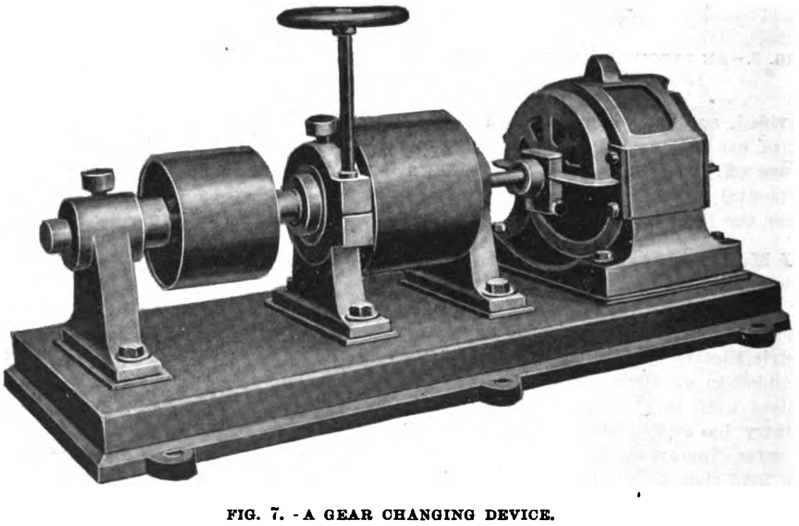


FIG. 7.—A GEAR CHANGING DEVICE.

frequently causes breakage. The nature of the action is a little difficult to understand, but may be explained by reference to the sectional drawing, Fig. 8. Here M is an oil-tight gear case provided with hubs, N and N, which act as bearings for the sleeves, B and G, which are keyed to the driving and driven shafts respectively. On B is a bevel pinion meshing with two beveled gears carried on two inclined shafts, free to rotate within the gear case, M. One of these inclined shafts appears in the illustration, the other being in the lower half of the section. Each of these inclined shafts carries two gears which rotate as one, the larger meshing with both B and H, and the smaller one with the driven member, G. If the outside case is clamped tightly so that it cannot ro-

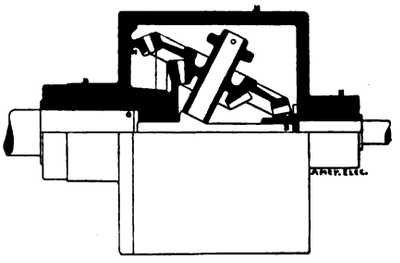


FIG. 8.—SECTION OF CHANGEABLE GEAR.

tate, one speed reduction is obtained, while if it is released and allowed to rotate the speed reduction is greater. By bringing out a sleeve attached to the member carrying the two inclined shafts and clamping this, still a third speed ratio can be obtained. Various other relations of the parts can be made so that other effects can be obtained. For instance, the whole apparatus may be clamped together so that all parts move around as one, the gear ratio in this case being unity.

**The Latest Improved Form of the Aron Integrating Wattmeter.**—In continental Europe clock-work meters are to a large extent used to measure the power delivered to consumer's premises in place of the motor meters almost universally used in this country. The most popular form of these clock-work motors is the Aron meter, the latest form of which is shown in Fig. 9. The principle of the old instruments, as well as the new, is to record the difference in speed between two pendulums, the downward pull of one or both of which is affected by the load upon the meter. These two pendulums are driven by clock-work and together drive a train of recording dials through a differential gear like that of a single motor

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automobile, so arranged that if the speed of the two pendulums is the same the gear train is not moved, but if either pendulum runs faster than the other the gear train is driven at a speed proportional to the difference. In the wattmeter form the pendulums carry shunt coils below which are series solenoids which pull one shunt coil down and repel the other when current passes through them. As the speed of a pendulum of a given length changes when its downward attraction is changed, the two pendulums will run at different speeds when the load comes on and thereby tend to record it on the dials. It is obvious that friction does not affect the indications of this instrument at low loads, as it does that of motor meters, and that the instrument is as sensitive at no load as at any other. If the two pendulums are not perfectly synchronized they will make a record either forward or backward when there is no load upon the instrument. This is one of the disadvantages of the old instrument overcome in the new, which automatically from time to time reverses the electrical and mechanical connections so that if one pendulum tends inherently to run faster than the other it will drive the gear train forward half the time and backward half the time, leaving a zero record. The instrument is also self-winding by devices similar to those used in self-winding clocks in this country. It also starts itself automatically when the current is turned on, and stops its mechanism automatically when the difference of potential vanishes from its shunt coils.




FIG. 8.—THE ARON METER.

**The Reappearance of the Internal Reflector.**—After irregular intervals there appears on the market an incandescent lamp with a reflector inclosed within the loop of the filament. The latest freak of this kind is a lamp of English make, illustrated in the accompanying cut. Descriptions of the lamp in the pamphlets and other advertising matter devoted to it, state that it contains within the bulb a reflector made of clear glass silvered inside, or of white opaque glass with or without a silver coating on its interior. The claims are made that it intensifies the rays of light, reflecting them out in every direction; that it absorbs heat, which lengthens the life of the filament and occasions a great saving in the consumption of current; that it trebles the light, and also that it is the greatest improvement on the incandescent lamp since its invention. It is obvious that any reflection in one direction must take away from the light sent out in another direction and that no increase in the mean spherical candle power can be effected in this manner. If the reflector absorbs heat it simply reduces the temperature and consequently the efficiency of the filament, unless more energy is delivered to the lamp to maintain the temperature at the proper value for a given brilliancy. The great saving in the consumption of current and the multiplication of the light have been anticipated by many previous inventors, who have spent hard-earned money on experiments in the same line because their inventive faculty was unaccompanied by sufficient knowledge of some of the simplest laws of science.

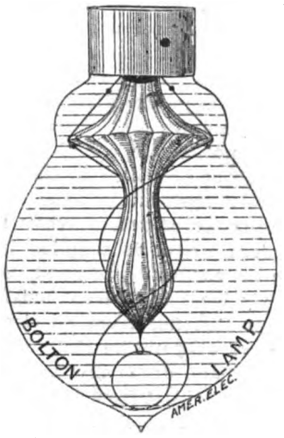



FIG. 9.—AN INCANDESCENT LAMP WITH INTERNAL REFLECTOR.

## NOTES.

**A Floating Electric Light Plant.**—The United States Navy will equip a tug boat called the "Apache" with an electric light plant, which will enable the boat to be used as a light boat for lighting vessels out of commission or that may be undergoing repairs.

**The American Association for the Advancement of Science.**—The forty-eighth annual meeting of this association will be held at Columbus, Ohio, August 19th to 26th, 1899. The association's headquarters will be located at University Hall of the Ohio State University.

**Large Prizes Offered for Inventions.**—President C. J. Glidden of the Erie Telephone & Telegraph Company has stated that he would give $1,000,000 for a telephone repeater as satisfactory as the telegraph relay. He has also made the same offer for a means of quadruplexing telephone instruments.

**A Novelty in Automobiles.**—An electric vehicle manufacturing house in Toronto, Ontario, has constructed a motor-driven invalid's chair, which is unique in being the smallest motor carriage in the world, the width over all being only about 2 ft. It is equipped with 3 cells of storage battery, weighing 33 lbs. and a small motor capable of driving it at a maximum speed of 4½ miles per hour.

**New York to Boston by Trolley.**—A. I. Prime, a New York lawyer, his wife and sister, arrived in Boston on July 13, from New York, having traveled almost the entire distance by trolley. The trip took about twenty-nine hours, exclusive of stops. Two hundred and five miles were covered by trolley and only fifty-two by train. Thirty different lines were passed over.

**A Long Run With an Automobile.**—The longest trip of storage battery automobiles ever reported is that of Comte de Chasseloup Loubet, who drove, July 2d, from Paris to Rouen without recharging, the distance being some 85 miles, and the time 7 hours and 15 minutes. After recharging, the return trip was made the same night in practically the same time. The vehicle was of the Jeantaud make.

**The Electrical Exposition at Como Destroyed by Fire.**—The buildings containing the electrical exhibition celebrating Volta's discovery of the electric pile were completely destroyed by fire on the morning of July 8th; cable messages report also that many scientific records and relics of Volta were lost. The exhibition was opened on May 15th and was to have remained open until October.

**The National Association of Municipal Electricians** will hold its next annual convention in Wilmington, Delaware, on Sept. 5th and 6th. In connection therewith there will be an electrical exhibition during the entire week. Papers will be read by Thos. Flood, Commissioner Wire Department, Boston; M. W. Mead, City Electrician, Pittsburgh; Capt. Wm. Brophy, Electrical Engineer, Wire Department, Boston, and other men well known in this line of work.

**Enormous Orders for Electric Automobiles.**—Mr. Isaac L. Rice, president of the Electric Storage Battery Company, is authority for the statement that orders have recently been placed for 4200 vehicles at an aggregate selling price of some $8,000,000. These consist of about 2000 pleasure vehicles, 2000 hansoms and broughams and 200 delivery wagons. The greater part of them will not be sold, but will be operated by the local sub-companies of the Columbia and Electric Vehicle Company.

**Westinghouse Electrical Apparatus to be Manufactured in England.**—It is rumored that the Westinghouse Electric Company, Ltd., an English corporation closely associated with the Westinghouse Electrical and Manufacturing Company, has acquired 100 acres of land close to Manchester, England, and will immediately erect works covering 40 acres, practically du-

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plicating the Pittsburg plant. The works will be capable of employing 5000 hands. Lord Kelvin will be the electrical adviser of the company, and it is said the enterprise is backed by £1,500,000 of British capital.

**Control of the Stanley Company Changes Hands.**—It is stated on good authority that the control of the Stanley Electric Manufacturing Company, of Pittsfield, Mass., has passed into the hands of New York parties, and is for the present held by them as individuals, although it is understood that the sale means a consolidation with the Sprague Company. The price paid for the Stanley stock was $150 per share.

**Castings for the Single-Phase Rectifier.**—The design for a machine of this type prepared by Mr. J. C. Brocksmith and published in the June issue of the American Electrician has occasioned so many inquiries for laminae, castings and other parts that the editor of the American Electrician would be glad to have any one who has constructed this machine and is willing to supply these parts, quote prices for the same. For the benefit of readers who may desire to obtain such parts any offers will be published in these columns.

**A Canal Lift Controlled by Electric Motors.**—The large lift on the Dortmund and Ems Canal in Germany, capable of raising or lowering 600 ton barges, is controlled by electric motors. The lift is counterbalanced and operated by the addition of sufficient water to lower it, which is withdrawn when the lift is to be raised. The motion is governed by four enormous steel screws 81 ft. long by 11 ins. in diameter, which are rotated by electric motors. Other motors control the gates and drive the pumps.

**Electrical Research a Criminal Penalty.**—The following clipping from London "Lightning," exhibits a rare instance of the similarity of English and American slang, as well as what is still more rare, an international pun:

"From a storeroom of the London Electric Supply Corporation George Perrott took some copper. Then the order of things was reversed, and a copper took him. When the scene changed to the Greenwich Police Court, George was invited to spend 21 days in studying the conditions that exist in a dry cell of high internal resistance. He is now engaged in pursuing the suggested course of research."

**Electric Power in the Baltimore Tunnel.**—It appears that the information on which was based a note that appeared in the last issue of the American Electrician on this subject was erroneous. Electric locomotives are used for all eastbound freight trains, and all but a few passenger trains passing in the same direction, the crowded condition of the section rendering it necessary to run a few of the latter trains through under their own steam. Westbound trains run without the electric locomotives on account of the down grade. There is no delay in coupling or uncoupling, as the former is done in the Camden station, at one end of the tunnel while the passengers are getting on and off, and a flying cut-off is made at the other end.

**A Novelty in Cooling Machines.**—A new application of thermodynamics to domestic purposes has recently been developed in the shape of an air cooling apparatus for offices, apartments and habitations. It is a somewhat radical departure from previous methods in that the source of the cooling is not, as generally heretofore, the conversion of heat into mechanical work, but merely depends upon the latent heat of vaporization of water. Water from any convenient source is supplied in a thin film to the copper top of an air flue and a sharp air blast is directed axially along and over this flue from an electric fan. The forced evaporation chills the air flue vigorously and drops the temperature of the whole air blast from 10° to 20° F., according to the rate of evaporation attained.

**A Freight Barge Driven by Electric Motors.**—A firm of manufacturers near Birkenhead, England, has equipped one of its barges for carrying freight around the harbor of Liverpool with accumulators and motors instead of steam boilers and engines. The craft is 75 ft. long with a displacement, loaded, of 225 tons, its cargo consisting of 150 tons. The driving equipment consists of 112 storage cells, weighing 400 lbs., each with a capacity of 2000 ampere hours at a 7-hour discharge rate. The vessel is propelled by twin screws worked by two 40-h. p. motors. A small electric crane is also a part of the equipment. The advantage of the electric driving is said to be the increased cargo capacity and reduced risk of heating.

**The Electrical Manufacture of Caustic Soda and Bleaching Powder at Niagara Falls.**—A new plant for the electrolytic decomposition of sodium chloride or common salt is now being built at Niagara Falls by the Acker Process Company. The works will utilize 3000 electrical horsepower, to be delivered in the form of 8000 amperes of direct current at 300 volts pressure, to be generated by the Niagara Falls Hydraulic Power and Manufacturing Company. These 8000 amperes will pass through a single series of decomposers, the great peculiarity of which is the fact that the salt is dry and molten instead of in solution. This condition increases greatly its conductivity and is said to improve in some ways the output. The high temperature will be maintained by the $C^2R$ losses.

**Electric Traction on the New York Elevated.**—At the meeting of the Manhattan Railway Company, held on July 11, it was decided to place a contract with the E. P. Allis Company, Milwaukee, for eight 8000-h. p. engines capable on overloads of developing 100,000 h. p. The company had already selected a location for a power house and placed a heavy order for third rails. These engines will be by far the largest ever used for driving electrical generators, having just double the capacity of the eleven 4000 h. p. sets now under erection for the Metropolitan Street Railway Company, New York City. The power station of the elevated will have exactly the same capacity as that planned for the Third Avenue Railroad of New York City, for which sixteen 4000 h. p. units were proposed.

**Telephones on Street Cars.**—The new motor cars which are to be used on the suburban line between St. Paul and Stillwater will be equipped with a system of telephonic communication with the main office. As the new road is a cross country line, there will be miles of open country between stations. In case of accident when the cars are out in the country, it is important that the motorman should be able to communicate quickly with the home office. For that purpose each car is supplied with a telephone placed in the front vestibule. The telephones are supported by springs, so the jolting of the car will not jar the instruments. At the feed poles, which are placed a quarter of a mile apart, the motorman can "plug" in his telephone and open communication with the head office. In case a car is disabled or snowed in, the office can be advised and relief dispatched.

**The Prevention of Gas Explosions at Cut-outs and Switches.**—A simple and ingenious means has been adopted in the Cleveland intake tunnel to prevent the ignition of any explosive mixture that may occur at the electrical fuses or switches. The tunnel is being built to supply Cleveland with water from a crib situated 26,000 ft. from the shore. Two explosions occurred in the running of the first drift, costing several lives. It was claimed that the gases were ignited from the electric lighting fixtures. When the work was resumed at the point where the gas belt was touched, branches were led from the supply pipes of the compressed air system to the cabinets containing the switches and cut outs. A current of fresh air was constantly introduced into these cabinets, in this manner keeping the gases from accumulating therein, so that when fuses blew or the switches were opened there was no danger of explosion.

**The Convention of the Independent Telephone Association.**—The annual meeting of the Independent Telephone Association at Chicago on June 26th, 27th and 28th gave further proof of the stable character and growing importance of the independent telephone interests. The attendance was large, amounting to some 250, and of a character which must have favorably impressed the representatives of capital who are beginning to interest themselves in this field of such

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great apparent promise. The papers presented departed in character from those of previous years by taking up broad questions of policy and general problems of construction, rather than the struggles of local companies against the Bell interests. The association of the independent companies has developed a power of no mean proportion when compared even with that of the Bell companies themselves. The number of independent exchanges was given at the convention as 2500, serving some 300,000 subscribers, with a total investment of over $50,000,000.

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**The Rule Against Automobiles in Chicago Parks Declared Void.**—Judge Gibbons of the Circuit Court of Cook County has decided that the rule of the South Park Commissioners of Chicago barring automobiles from the parks and boulevards of the city is void. The decision was rendered in the case of an engineer of the American Electric Vehicle Company who ran an automobile on Jackson Boulevard to bring a test case. The opinion is based on the unreasonable nature of the ordinance "when, as a matter of common observation and scientific knowledge, there is less danger in propelling an automobile than there is in driving a horse and buggy." The opinion further states "the time is not far distant when no horse car, trolley car or cable car will be permitted to occupy any of our business streets; they have served their purpose, they should be either above or below the surface of our streets." Judge Gibbons certainly shows an iconoclastic spirit.

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**The Dangers of the Third Rail.**—Remarkably few accidents have been recorded on the various railway installations in this country, notably those of the New York, New Haven & Hartford, Brooklyn Bridge and the elevated roads in Chicago. Accounts occasionally come from the former of the cremation of a stray dog in stepping from the third rail to one of the service rails or the disappearance of a steel rod umbrella dropped across the tracks. Track repairmen on these lines have found them less dangerous than might be expected, frequently allowing themselves to get shocks which prove of no consequence. This is undoubtedly due to the fact that currents obtained enter or leave the body as a rule through the feet, and the stockings worn, when dry at least, serve as a fair insulator against street railway voltages. An instance where this protection was not afforded and where the danger immediately became evident is recorded in Chicago, where, on June 30th, a small bare-footed boy climbed on to the structure of the Metropolitan Elevated, stepped from the third rail to one of the others and was electrocuted instantly.

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**The Municipalization of the Detroit Street Railways Stopped.**—The proposed plan of Gov. Pingree and others for the municipal ownership of the street railway system of Detroit has received two serious checks. The ordinances brought before the Common Council were laid on the table on June 27th and the State Supreme Court on July 5th stated that the law authorizing the appointment of the street railway commission is unconstitutional. An attempt was made to get around this Supreme Court decision and dispose of the valuable plants which the Citizens' Traction Company now owns and will have on its hands at the coming expiration of the franchises, by forming a new company, known as the Detroit Municipal Railway Company, and putting through the local Council a "security franchise," designed to secure the bonds with which the new company proposes purchasing the existing railway systems. The security franchise provided for six-for-a-quarter fares practically for 48 years. This franchise was vetoed by the Mayor and failed to pass the Council over the veto. Mr. T. L. Johnson then sent a communication to Gov. Pingree, indicating his purpose of abolishing tickets and transfers and endeavoring to make the most money possible out of the property during the remainder of the franchise term.

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**Electric Street Railways for London.**—One of the last of the world's great cities to adopt electric traction is the greatest of all, London. The prejudice against the trolley car is, however, dying out and the electrical equipment of a large portion of the London United Tramways has recently been commenced. When completed, this will comprise 40 miles of electric lines, operating some 250 motor cars. The distribution of current is peculiar. A double trolley will be used, as the company has been debarred from using a ground return. The double trolley will be arranged on the three-wire system, the two inner trolley wires of the double track line being connected together and forming the neutral, the two outer trolley wires forming the positive and negative, respectively. The neutral will be grounded at the power station only, to prevent any possibility of a ground return. The outer conductors will be divided into half mile sections fed by independent feeders from the power station, the neutral being similarly arranged in sections three times as long. One part of the line will be operated from a sub-station equipped with transformers and rotary converters, supplied with power at 5000 volts, three-phase, 25 cycle. Two rotary converters, one for the positive and the other for the negative side of the system will be mechanically coupled to each other for balancing the load.

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**An Extensive Theft of Electric Current.**—The Chicago Edison Company has arrested the engineer of an office building in the business section of Chicago on the charge of stealing some $5000 worth of power from the company's underground lines. It would appear from the press accounts that he was accused of having used a break-down connection for some three years' time, drawing some $5 worth of power every night. An interesting story of the detection of the theft is told as follows in one of the Chicago papers: A month ago the Edison Company became aware that its lines were tapped somewhere in Dearborn Street between Van Buren and Harrison streets. The case was put into the hands of a detective agency. The detectives made a tour of all the office buildings along Dearborn Street in the guise of fruit peddlers. Their suspicion at last fell upon the engineer of the building at 327 and 329 Dearborn Street. By telling the engineer a "hard luck" story one of the detectives, with his basket of fruit, was allowed to stay for several hours one rainy night in the shelter of the engine room. While there he saw the engineer go under the sidewalk and throw an electric switch. The dynamo in the building was then turned off, but 65 lamps still gave forth their usual light. The detective found that the dynamo was stopped every night between midnight and 6 o'clock.

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**Novelties in Transmission Line Construction.**—The 31-mile line of the Kootenay-Rossland Transmission Company in British Columbia consists of two parallel and duplicate pole lines, on one of which the cross arms are roofed over to prevent the wet snow from piling up on the cross arms around the insulators, which it does to a height of some 18 to 24 ins. during seasons when there is no wind. The cross arms are two in number, the upper one some 8 ft. in length with 4 pins, and the lower shorter, holding two pins. The upper one is covered with a cedar roofing 24 ins. wide, sloping slightly downwardly from the pole each way toward the ends of the cross arm. The lower, immediately below it, is roofed to a width of 16 ins. During the past winter service was continued over both lines, even when the exposed line had from 10 to 12 ins. of snow on the cross arms. If any leakage existed it was impossible to detect it, so that the roof appears to be quite an unnecessary precaution. Another peculiarity of the same line is the crossing of the Columbia River, which is in a single span 1500 ft. in length. The wires are No. 000 bimetallic, maintaining a conductivity equal to that of the balance of the line, which is No. 0 copper. These spans are unsupported by strain cables, the total sag being some 52 ft. with the strain taken up by a number of ordinary porcelain insulators in a strain tower at each end of the crossing. The interaxial distance betwen the wires is only 6 ft., but no trouble has been experienced from swinging crosses or from breakage due to wet snow, which has at times adhered to the lines to a diameter of about 4 ins. These facts are taken from an illustrated description of the system published with the usual clearness and thoroughness of illustration characteristic of the "Journal of Electricity."

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### The Handling of Railway Car Controllers.

Frequently the general manager of a street railway sytem, learning that an electric car requires only half as much current to drive it on the series notch as it does on the parallel notch, instructs his motormen to use the series notch to the exclusion of the other on heavy grades and slow schedules. While the use of the controller notch, which puts the motors in series with no resistance in the circuit, is far preferable to that of any notch inserting dead resistance, yet a little consideration will show that the use of the highest speed, or parallel notch, is preferable in more cases than would be imagined at first thought.

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Taking the case of heavy up grades the torque or draw-bar pull required to move the car at a uniform speed is approximately the same, whether that speed is high or low. To render the argument more clear, let us assume a definite case of a grade such that each motor must deliver a torque requiring 40 amperes. If the car is run up this grade with the controller on the series notch all the current taken by the car passes through both motors and the total demand from the line is only 40 amperes. If the car is run on a parallel notch 80 amperes will be taken from the line, 40 going to each motor, but in the former case the car will run only half as fast, or in fact somewhat less than half as fast, since the ohmic drop in the motor circuit is twice as great when the motors are in series as it is when the motors are in parallel. Thus the car will require somewhat over twice as long to climb a given grade, and, since the current in each motor is 40 amperes in either case, the total amount of energy wasted in $C^2R$ losses, which heat up the motors, will be over twice as great for a given climb if the series position of the controller is used. Another explanation of the same action is the fact that when working in series the motors are run at a much slower speed and hence at a much lower efficiency. This heating of the motors in case a route has many heavy grades may prove a serious factor, burning out many car equipments unless particular instructions are given to use the full speed position as much as possible in order to get up hills at the highest permissible speed. The same argument applies to running at a uniform speed on a level. In covering a given route about twice as much heat will be generated in the motors if they are run in series as if they are run in parallel. Electric locomotives and other slow running cars, swing bridges, or other pieces of apparatus, are often fitted with two or four motors, run frequently two in series. If these motors were geared with twice as great a reduction they could be run in parallel and would do twice as much work with practically the same heating.

---

Another case arises, however, in which the series connection of the motors is advisable, and for which special instructions to motormen may prevent serious trouble, and that is the case where the demand upon the distribution system or any particular feeder becomes so great as to cause an excessive drop between the power house and the cars. Instances of this kind frequently occur on suburban lines, reaching parks, summer resorts or beaches, with heavy loads of such infrequent occurrence that the use of much copper for feeding them is unwarranted. If a large number of cars start running about the same time on such a line distant from the power station—as often occurs after the closing of an entertainment—the excessive demand for current may cause a drop of several hundred volts in the line, so that even if the circuit breakers are held in at the station the cars get hardly pressure enough to crawl along and not enough if heavy grades are encountered. If, under these circumstances, the motormen are instructed to run on the series notch each car will require only half as much current, and the drop in the line will be so much less that the cars will make practically the same speed as though they were running on the parallel notch with a lower voltage. The current required for running the cars over the route will thus be reduced 50 per cent.

---

For ordinary running with frequent stops both calculation and experiment have shown that the greatest economy of power is obtained by starting the cars as rapidly as possible, advancing the controller notch to the full speed position as soon after starting as the capacity of the motors and the comfort of the passengers will permit, and turning off the power completely as soon as conformity with the schedule will permit, allowing the car to drift as long before the brakes are applied for the next stop as possible. This is due to the fact that a large part of the power given to electric cars is required to accelerate them and is afterwards thrown away as heat at the brake shoes. If the car is allowed to slow down by drifting, considerable of this energy absorbed in acceleration is afterwards utilized in overcoming legitimate frictional resistance of running and is not wasted in braking. In order to make schedule time with so much drifting rapid acceleration is necessary. It will be found by trial that this method of running cars will show a far smaller consumption in kilowatt hours per car mile than slow and gradual acceleration up to maximum speed and braking from that speed down to the next stop.

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**Unitooth Alternators.**

Probably the first impression of the reader familiar with alternating current machinery on noticing the views of the station of the Louisville Electric Light Company, on pages 367 and 371 in this issue of the American Electrician, will be one of surprise at the great length of the field magnets. While these machines are only a few years old and, in fact, of a class—direct coupled alternators—still somewhat rare in American central stations, they represent a practice already obsolete in the construction of large dynamos, and that is the use of unitooth or pole-wound armatures. In the machines referred to the armature coils are wound on poles—equal in number to those of the field—which poles have a length, indicated by the protecting rim attached to the fly wheel, almost as great as the length of the field poles of more modern machines. In fact, the armature of one of these machines could probably be used very satisfactorily as the field of a revolving field machine if the original stationary field were removed and replaced by a modern stationary armature with distributed windings.

---

The great reduction of the weight which would follow such a change indicates the advance in alternator design which has been made within the last few years. This advance is due largely to the distribution of the armature winding in a large number of slots per pole, very much like the winding of a direct current machine. By this means the self-induction of the armature is greatly reduced, as is the reluctance of the magnetic circuit, both factors reducing the necessary ampere turns for field excitation, and thereby reducing the length of the field magnets required to hold exciting coils of sufficient power. Incidentally the improvement reduces the losses of the machine and gives a better wave form to the alternating current delivered.

---

**Feed Water Heaters vs. Economizers.**

In the present state of the art of power production by steam the managers of but few installations of any size—and especially is this true of central stations—are so short-sighted as to get along without one or the other of these devices for restoring heat which otherwise is wasted at one or the other of two stages in the making of the final product, power. Some few small plants, where the cost of fuel is very low, or where an annual saving of from $25 to $100 is not considered sufficient incentive for an initial investment of $200, continue to work without them, the chief excuse being the ease and simplicity of feeding the boilers by means of injectors, which, of course, cannot be used for feeding hot water.

---

As a general rule, both an economizer and a feed water heater are not considered necessary, as either one alone will raise the temperature of the entering water a good ways toward that of the steam within the boiler. The determination of which should be used in any case depends largely on local conditions, a few of which are outlined below. If the exhaust steam is entirely used for any other purpose, such as heating, as it is in most isolated plants a good part of the year, an economizer should be used for heating the feed water. If the plant is non-condensing and the exhaust steam is not used for heating purposes, but is simply thrown away, the feed water heater would seem to be preferable for several reasons which are pointed out in a letter on the subject which appears on other pages of this issue. Among these reasons are the lower initial cost, and, as a rule, the lower cost of maintenance, as the economizer requires running machinery to scrape the soot from its tubes. It should be noted, however, that an exhaust steam heater cannot, under any conditions, raise the temperature of the feed water above 212° F., while an economizer may, if its heating surface is sufficient, raise it to boiler temperature; about 350° F., if the pressure is about 125 lbs. In fact, with a wasteful boiler some steam may be generated in the economizer before the feed enters the boiler. On this account economizers must always be run under boiler pressure, while feed water heaters of the open type may be used, or of the closed or surface type may be run under atmospheric pressure on both sides of the heating surface, the water being pumped hot in either case.

---

In case of a condensing plant there are two alternatives. One of these is the use of economizers for heating the feed water and the application throughout the equipment of mechanically or electrically driven pumps and other auxiliary applications of small powers about the plant. Steam driven auxiliaries are extremely wasteful of steam and should never be used where their exhaust steam is thrown away, as it is in plants with economizers. They are, however, much more easily controlled and varied in speed than are auxiliaries mechanically or electrically operated, and obtaining, therefore, the high steam economy of the main engines. This ease of control and the loss of draft consequent upon the use of economizers, which loss of draft necessitates either mechanical draft or a higher chimney, induces many central station engineers to favor steam auxiliaries exhausting into feed water heaters, which return their waste, in place of economizers and electrical auxiliaries.

---

If jet condensers are used and the initial source of the boiler feed is stone cold, the exhaust of the auxiliaries, wasteful as they are, will hardly be found sufficient to raise the feed to 200 degrees or more. Under these conditions it is becoming customary to use closed or surface primary heaters for transferring some of the heat of the engine exhaust to the cold feed water, which is afterward passed through secondary heaters, taking the exhaust of the auxiliaries for further raising the temperature of the feed. The primary heaters cannot be expected to do very much since the exhaust steam passing through them is under vacuo and its temperature is only from 125 to 150 degrees F., according to the perfection of the vacuum. Enough heat, however, can be saved to warrant the expense of such primary heaters, and they assist in the condensation of the exhaust. The temperature of the feed may be raised in the primary to 100 degrees or somewhat more and in the secondary heaters, taking exhaust steam at atmospheric pressure, to 200 degrees. The secondary heaters are often fitted with a live steam supply to reinforce the heat saved from the engine and auxiliary exhausts. While the use of live steam for feed water heaters may seem like lifting one's self up by one's boot straps, experiment has shown that there is, for some reason, an economy in its practice, provided there is no other means for heating the feed water up to about boiling point.

---

Where surface condensers are used and the condensed water is returned for boiler feeding, primary heaters are of no value, since the temperature of the hot well is practically as high as any that can be obtained by passing the feed through such a heater. As a rule, however, the difficulties of separating oil from the exhaust steam or feed water make a supply of fresh water from an outside source preferable, unless its cost is excessive or its chemical character so bad as to render its purification a matter of difficulty.

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## CONSTRUCTION OF THE SINE CURVE.

BY GEORGE T. HANCHETT.

For accurate testing and similar work involving alternating currents, it is frequently very desirable and is sometimes indispensable to have a source of e.m.f., which accurately follows the sine law. Typical of these cases are the calibration of instruments, the use of secohmmeters in connection with a Wheatstone bridge, and many other cases which might be mentioned where a true sine e.m.f. is indispensable for accurate work. Indeed, a current having this property is so highly desirable that numerous attempts have been made to build a small dynamo with the pole pieces so shaped as to cause the machine to generate an e.m.f. of the desired wave form.

In such devices as these efficiency is not a consideration, and accuracy is everything. Simplicity is also desirable. In the following paragraphs the writer ventures to call attention to some devices which will produce an accurate sine e.m.f., and some of which, so far as he is aware, are original.

A simple rectangular coil, suitably mounted on an axis which is placed at right angles to the earth's field of force, will, if rapidly rotated, produce a true sine e.m.f., provided that the current drawn from it be not so great as to react on the earth's field and destroy its uniformity. A device of this kind is shown in Fig. 1. A brass spider which may be conveniently made from a single casting is provided. The wire is tightly wound on this frame and the ends are brought down to two collecting rings on which suitable brushes are made to bear and from which the experimental current may be drawn. It is not difficult to see that a drum armature, which is a succession of such rectangular coils, may be provided with two collecting rings at equally distant points on the winding and similarly placed in the earth's field and rotated, thereby producing an e.m.f. of the desired character; and indeed this is true of any bipolor armature. The objection to these devices is the high speed at which they must be driven in order to obtain commercial frequencies, for the earth's field is essentially a bipolar one. The armature will give one complete cycle at every revolution, and if a frequency of 8,000 cycles per minute is desired, 8,000 revolutions per minute must be made, which is a dangerous speed for any armature. Moreover, the irregular shape of overwound drum armatures and the complication of iron in the circuits arranged with other purposes than this in view, and the distorting effect of eddy currents, render this device rather unsatisfactory and more of an expedient than good practice.

The rectangular form shown in the figure is perhaps better than the use of an armature for the reason that it can be constructed simply and accurately and in such a manner that it is not likely to fly apart. Unfortunately, only very minute currents can be drawn from these coils, or the earth's field will be distorted and with it the sine e.m.f.

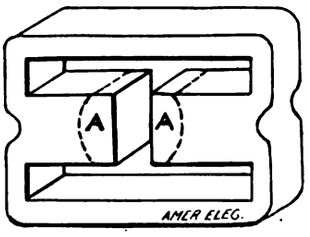



FIG. 2.—DEVICE FOR PRODUCING AN ACCURATE SINE E. M. F.

A more suitable field can be provided for the purpose of such experimentation as this by means of a very heavy magnet, with two opposite and parallel poles. These poles should be very large in proportion to the armature for which they provide a field. The edges should be rounded slightly, for the flux of force tends to concentrate, there. A small loop, or, better still, a little drum armature wound on a wooden core, may be revolved in such a field as this, and will give a sine e.m.f. Considerably more current can be drawn from this device than from one in which the earth's field is used. An old dynamo frame of the form shown in Fig 2 will make an excellent field for such a purpose as this, if the polar recesses are suitably filled with semi-cylindrical blocks, A A. One of the horse shoe type will not be satisfactory, for the flux will concentrate on the edges which are next to the winding.

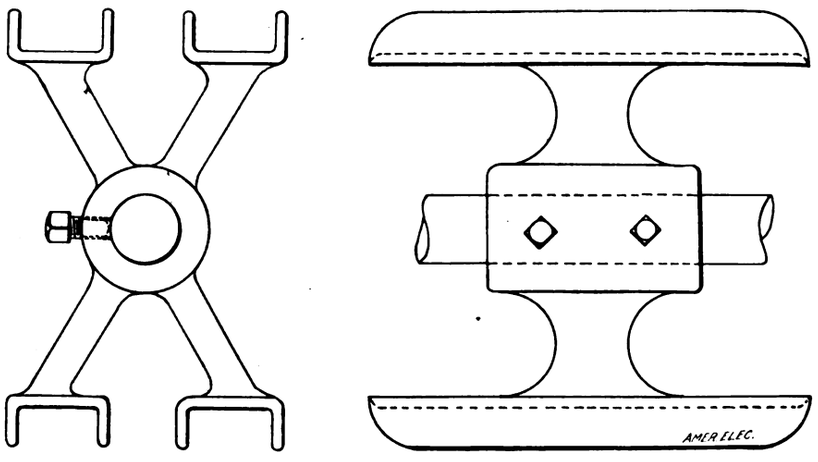



FIG. 1.—DEVICE FOR PRODUCING AN ACCURATE SINE E. M. F.

Another ingenious method is shown in

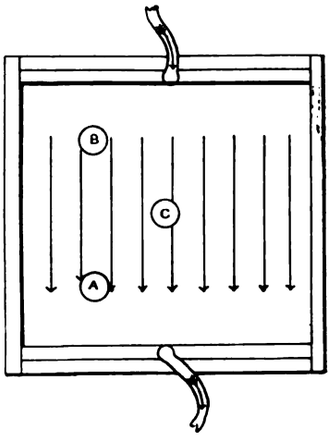



FIG. 3.—DEVICE FOR PRODUCING AN ACCURATE SINE E. M. F.

Fig. 3, but unfortunately is not practicable for anything but very low frequencies. A rectangular tank is provided, in the center of which is immersed an electrode, C, of metal or carbon as may be convenient. Another electrode, A, is also immersed in the tank, and by use of suitable machinery is made to travel about the first in a true circle, being driven by a suitable motor at constant speed. On opposite sides the tank is lined with plates, and current passes from one plate to the other as shown by the arrows. It distributes itself uniformly, the lines of flow from plate to plate being straight lines and normal thereto. If these conditions obtain, it will be seen at once that the various points of potential through which the moving electrode passes vary in their differences from the potential of the stationary electrode according to the sine law. It is obvious that these devices can be rotated only very slowly. If we place in the tank another moving electrode, B, 90 degrees in advance of the first, we may draw two-phased currents from the two electrodes, using the middle as a common return; and with three electrodes at 120 degrees apart, we may draw three-phased currents, all of which will be practically in sine curves.

In Fig. 4 is shown a device which should give a sine curve of great accuracy and which can be driven at speeds corresponding to some of the lower frequencies. A straight conductor is provided, and it is essential that this should be of uniform resistance and that the total resistance should be as high as possible. The conductor should be more or less substantial, as it has to stand the friction of a traveling brush and should partake of the nature of a rod or bar. The ends of this rod are connected to two or more storage batteries in series, care being taken that the number of storage batteries be even. It is important that these storage batteries should be as much alike in every respect as it is possible to make them, for their e.m.f. should be of the

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same magnitude and their internal resistance should also be the same. They must, therefore, be charged together and, in general, subjected to the same treatment at all times.

Upon the rod which is thus supplied with current travels a small collecting brush, which is driven by the well-known crank disc and plate in a simple harmonic motion. A lead is brought out at the middle connection of the batteries and another is connected to the traveling brush. When

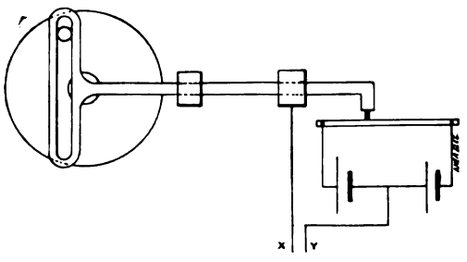



FIG. 4.—DEVICE FOR PRODUCING AN ACCURATE SINE E. M. F.

the machinery is set in motion there will exist between these two points or leads an e.m.f. which will closely follow the sine law. It will be readily seen that if the distribution of potential along the wire is uniform, varying directly as the length, and if the motion of the brush is harmonic, the potential varies in the same way. The machine should be carefully set so that the maximum rate of change of brush position shall correspond with the position of zero potential on the rod. To accomplish this, the crank disc should be set so that the pin is on a vertical line, and the brush should be adjusted along the driving rod until the potential between the terminals X and Y is zero.

Still another device which is somewhat similar in its construction and principle is shown in Fig. 5. Two circles are provided which are tangent to each other, but insulated from each other at the point of tangency. Circles may be cut from the ends of brass tubes of suitable diameter and mounted on a board. Over the face of this circle is rotated a current-carrying wire stretched in a frame. The centre of rotation of this wire corresponds to the point of tangency, and as at this place there is insulation, the wire touches the circles only on the outer contacts, even though it be in a secant position. Connections are made to the two brass circles, and between them an alternating sine e.m.f. exists. In this device and also in the device shown in Fig. 4 it is necessary to avoid drawing too much current from the circuit for the reason that unbalancing will occur in the wire over which the moving contact is made. To further reduce this error, the current in the stretched wire or rod should be very large, so large that the currents that will be necessary to use in the experimental circuit will be a very small percentage thereof.

Another device which is similar to that shown in Fig. 4, but which can be driven at higher speed, is easily constructed. In this arrangement the traveling brush is mounted on a parallel rod between two wheels which are driven at the same speed in the same direction. The brush so mounted partakes of an up and down motion as well as a lateral one, but neither of the motions interferes with the harmonic motion of the other. The brush makes contact with a current-carrying bar or wire. It must be of suitable form, so that the lateral motion will not interfere with its contact on the wire. The advantage of this apparatus arises from the fact that it can be driven at a much higher speed than the apparatus shown in Fig. 4, for the connecting rod can be balanced. The electrical connections are the same.

## A GIFT TO THE STEVENS INSTITUTE.

Andrew Carnegie has promised to give $50,000 to the Stevens Institute of Technology for a new engineering laboratory. Plans for the new building will be prepared at once. When completed the laboratory, it is expected, will surpass those of Cornell and Columbia and will equal that of the Massachusetts Institute of Technology, which is said to be the best in the country.

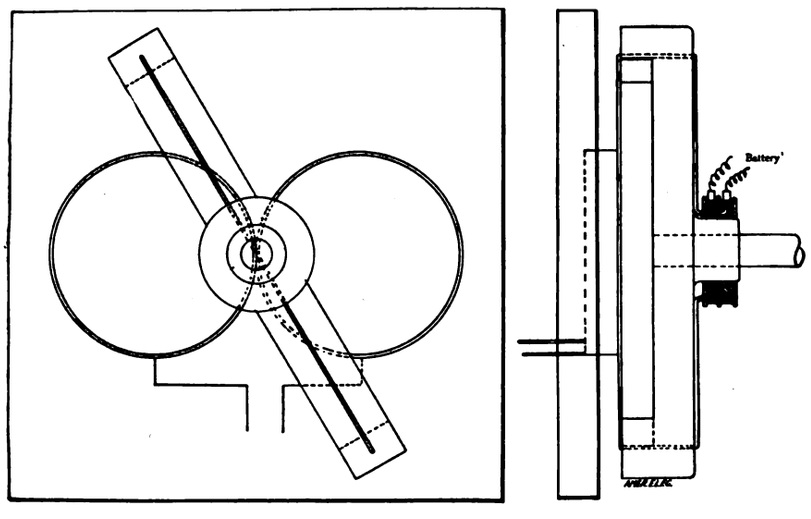



FIG. 5—DEVICE FOR PRODUCING AN ACCURATE SINE E. M. F.

## AMERICAN TELEPHONE PRACTICE.

### TESTING.*

BY KEMPSTER B. MILLER.

A very important measurement, especially in telephone cables, is the determination of the capacity of the line conductors with respect to all neighboring conductors. The usual method of making capacity tests is to note the deflection produced when a condenser of known capacity, after having been charged to a known potential, is discharged suddenly through the galvanometer, and to compare this

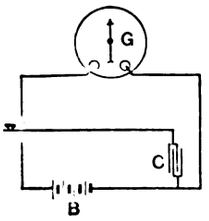



FIG. 1.—CAPACITY TEST.

with the deflection obtained when the cable or conductor being measured, after being charged to the same potential, is discharged through the galvanometer. The deflections produced under these circumstances are proportional to the charges, and therefore to the capacities of the standard condenser and the line or cable. The circuits for obtaining the deflection produced by the discharge of the condenser are shown in Fig. 1, where C is the standard condenser, B the battery, and G the galvanometer. When the key is depressed the condenser is charged to the full potential of the battery, B. The key is then suddenly released, thus allowing the charge from the condenser to pass through the galvanometer, thus producing a certain throw of the needle. The connections are then made as shown in Fig. 2, the same battery, B being used. When the key is depressed the cable is charged, and when suddenly released this charge flows through the galvanometer and produces another throw of the needle. By comparing the throw produced by the charge of the condenser with that produced by the charge of the cable, a direct comparison may be made between the capacity of the cable and that of the condenser. Thus, if with the 1/999 shunt the discharge from the condenser gave a deflection of 100 scale divisions the capacity of the condenser be-

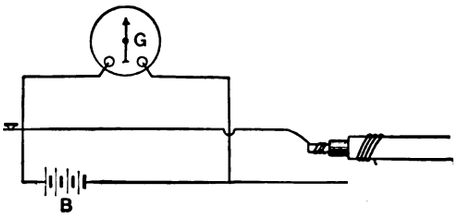



FIG. 2.—CAPACITY TEST.

* From a book to be published by the American Electrician Company.

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ing 1/10 microfarad, and if with the same shunt the discharge of the cable produced a deflection twice as great, we would know that the capacity of the cable was

$$2 \times \frac{1}{10} = \frac{1}{5} \text{ microfarad.}$$

Convenient connections for making capacity tests are shown in Fig. 3, where G is the galvanometer, S the shunt, C the standard condenser, KK discharge keys, V the selecting switch, and, B a battery of eight or ten cells. With the switch,

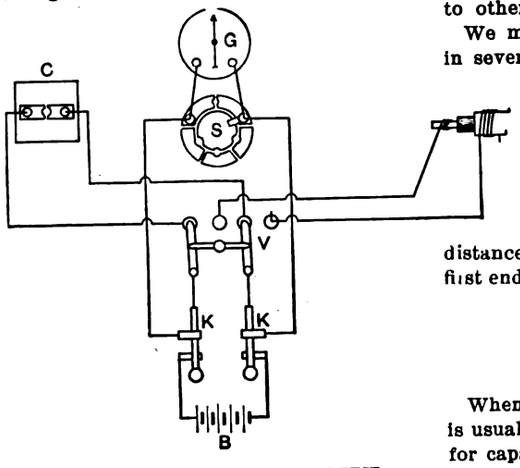



FIG. 3.—CIRCUITS FOR CAPACITY TEST.

V, at the left and both discharge keys depressed, the current from the battery will flow into the condenser, thus charging it. Upon the sudden release of the discharge keys, the condenser will discharge through the galvanometer and shunt, giving a deflection which should be noted. With the switch, V, at the right, the cable may be charged and discharged in the same manner, and the deflection produced by its discharge noted. About seven cells of battery are usually sufficient for making capacity tests on telephone cables. If a non-adjustable condenser only is available, one having a capacity of 1/10 microfarad is probably most desirable. For accurate work a subdivided condenser, having its divisions so arranged as to be easily connected in multiple or in series, or in combinations of the two, is very desirable. Then the condenser capacity may be varied until the throw from the condenser is nearly equal to that from the cable, thus greatly minimizing the liability to error in the results. In making capacity tests the wire under test should be carefully insulated and all the other wires in the cable should be connected together and to the sheath or ground. Fifteen seconds should always be allowed for the charging of the cable.

If d′ is the throw due to the discharge of the condenser, d that to the discharge of the cable, K the capacity of the condenser in microfarads, and X the capacity of the wire being measured, then

$$X : K :: d' : d$$

$$X = \frac{d'}{d} K.$$

If the throws of the galvanometer are too large to be measured, the shunt must be used. In this case d or d′ in the formula will be the actual throws observed multiplied by the multiplying power of the shunt.

### THE LOCATION OF FAULTS.

When a break occurs in a wire in a line or cable, the ends remaining insulated from other wires and the ground, the only recourse is to capacity tests. The capacity of the two parts of the wire will be proportional to their lengths, the wire being uniform in size and in its relation to other wires, throughout its length.

We may locate a break of this nature in several ways.

Measure the capacity of one end of the broken wire, then go to the other end of the cable and do the same. Calling D the length of the cable in feet, C the capacity of the first portion of the wire, C′ that of the other and X the distance in feet to the break from the first end, then:

$$X : D :: C : C + C'$$

$$\text{and } X = \frac{CD}{C + C'}.$$

When a good wire is available, and this is usually the case, set up the instruments for capacity testing, and take a throw, d, on the broken wire, another, d′, on the good wire, and a third, d″, on the good wire with the broken wire connected to it at the far end.

Evidently the throw on the whole broken wire would be $d'' - d' + d$.

Hence where D and X have the same significance as before

$$X : D :: d : d'' - d' + d$$

$$\text{and } X = \frac{dD}{d'' - d' + d}.$$

The location of breaks is much complicated by the presence of poor insulation between ruptured portions, and between other wires. The insulation resistances between these parts should always be taken. If less than one megohm, the results obtained by the capacity tests should not be relied on, and other methods too complex for description here should be resorted to.

The location of crosses or grounds is rendered somewhat difficult by the fact that there is nearly always some resistance in the fault itself. If we know the resistance of the defective wire and have no good wire running parallel with it we may proceed as follows, using a good Wheatstone bridge:

Measure the resistance of one end of the defective wire through the fault to ground. Do the same at the other end. Then calling R the total resistance of the wire (either known or calculated from its size and length), R′ the measured resistance from the first end, R″ that from the other end, X the resistance from the first end to the fault, Y the resistance from the second end to the fault, and Z the resistance of the fault, we have:

$$R = X + Y$$
$$R' = X + Z$$
$$R'' = Y + Z$$

Solving these for X and Y we have

$$X = \frac{R + R' - R''}{2}$$

$$Y = \frac{R - R' + R''}{2}$$

which values are independent of the resistance of the fault. Knowing the resistance to the fault, it is easy to compute the distance to it, from the resistance per foot of the conductor.

When a good wire is available, the Varley loop test should be used, as it is more accurate than the method just described. For this a Wheatstone bridge is used, and connected as in Fig. 4. The good and bad wires are joined at their distant ends, and one terminal of the battery connected to the point, e, on the bridge, while the other terminal is grounded.

The rheostat arm now includes the resistance, R, plus the resistance of the bad wire to the fault, while the unknown arm includes the resistance of the good wire, plus the resistance of the bad wire on the other side of the fault.

The equation of the bridge, when balanced, then becomes

$$\frac{A}{B} = \frac{R + X}{C + Y}$$

where R is the unplugged resistance of the rheostat, X the resistance to the fault, Y the resistance beyond the fault, and C that of the good wire.

Now calling K the resistance of the loop consisting of the good and bad wires, we have

$$K = X + Y + C$$
$$\text{or } C + Y = K - X$$

Substituting this in the second member of the equation of the bridge, we have

$$\frac{A}{B} = \frac{R + X}{K - X}$$

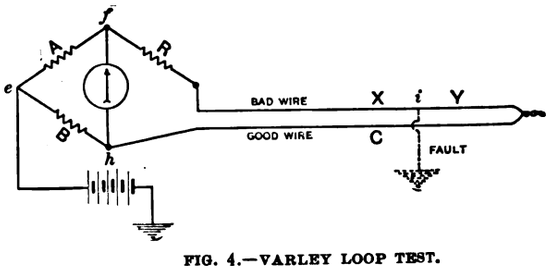



FIG. 4.—VARLEY LOOP TEST.

$$\text{whence } X = \frac{AK - BR}{A + B}$$

which is independent of the resistance of the fault, and of the resistance of the good wire.

Sometimes, in ordinary paper cables, the requirement is made that a rubber-covered test wire shall be run through the center of the cable, so that at least one good wire may be available in testing.

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## SAFETY VALVES.

Probably some of the young engineers of the present day, advanced as they are in the science of steam engineering, never saw one of the appliances here illustrated by Fig. 1 and termed a "Lever Safety Valve." However, it is but a comparatively few years since no other arrangement was known for the relief of steam boilers when the pressure became too high.

For years boiler tenders and firemen wrestled with sticking safety valves which would not open until they got good and ready and the pressure had risen far above the supposed blow-off point. But once a-blowing, the lever valve made up for its lateness in starting, for it would operate until the pressure in the boiler had fallen far below the normal.

Then this type of valve had a very ugly fashion of occasionally sticking fast to its seat, and in extreme cases the disc has been found so fastened to the seat that it was with difficulty broken away with a hammer. These valves are still in use in antiquated plants, and are manufactured because there is a limited demand for them for the reason that they are cheaper than the improved spring pop valve, three types of which are shown by Fig. 2, as manufactured by the Crane Company, Chicago, Illinois. This company is also the manufacturer of the lever type of valve as shown by Fig. 1. These valves used to be made by about every foundry or machine shop that could sell one of them, but few are made now-a-days for use on steam boilers.

Fig. 2 shows three types of "pop" safety valves, the "Standard" being shown with and without side outlet. The straight lever type is also represented and the details of construction may be readily inspected from the three views given. In adjusting these valves the springs are of such strength that one-sixth turn of the nut will change the pressure approximately five pounds either way. As the valves are self-adjusting, they require no changing after once having been set at the required pressure. The valve seats are bevelled at an angle of 45 degrees to the center line of axis and the lever is arranged to lift the valve off its seat to the extent of one-eighth the diameter of the valve opening in accordance with the rules and regulations of the United States Board of Supervising Inspectors of Steam Vessels.

Probably all the present styles of pop valves, as well as balanced valves for steam distribution, are based upon Richardson's original creation of nearly half a century ago. Foremost in the list of improvements upon Richardson's crude yet effective invention, may be placed the Crosby and Ashton valves. The Crosby, as illustrated by Fig. 3, is the original of encased locomotive pop valves employing a relief lever for convenience of relieving the pressure in the boiler. This valve can be changed to a higher or lower pressure without removing the valve or reducing the pressure in the boiler.

In the Crosby type, as shown by Fig. 3, the valve proper, B, acts upon two flat annular seats, V, V, and W, W, and is held down against steam pressure by the spiral spring S. The area contained between the seats W and V is what the steam pressure ordinarily acts upon to overcome the resistance of the spring. The area contained within the smaller seat WW, is not acted upon until the valve opens.

The larger seat, V V, is formed on the upper edge of the shell or body of the valve, A. The smaller seat, W W, is formed on the upper edge of a chamber or well, C C, which is situated in the center of the body of the valve and is held in place by the arms, D D, which connect it with the body of the shell. These arms have passages, E E, for the escape of steam from the well when the valve is open. This well is deepened so as to allow the rings, X X, of the valve proper to project down into it far enough to act as guides. The flange modifies the size of passages, E E, and turns upward the issuing steam.

When the pressure under the valve is within about one pound of the maximum pressure required, the valve opens slightly and the steam escapes through the outer seat into the cylinder and thence into the air; the steam also enters through the inner seat of the well, and thence through the passages in the arms to the air. When the pressure in the boiler attains the maximum point the valve rises higher and steam is admitted into the well faster than it can escape through the passages in the arms, and its pressure rapidly accumulates under the inner seat; this pressure thus acting upon an additional area, overcomes the increasing resistance of the spring and forces the valve wide open, thereby quickly relieving the boiler.

When the pressure within the boiler is lessened the flow of steam into the well is also lessened, and the pressure therein diminishing, the valve gradually settles down; this action continues until the area of the opening into the well is less than the area of the apertures in the arms, and the valve promptly closes.

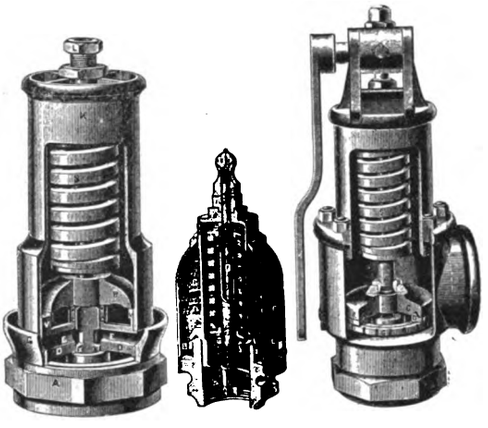


FIG. 3.—CROSBY POP VALVES.

In the Moody muffled form of pop valve the valve proper projects upward through the casing of the valve, as shown by the middle cut in Fig. 3. The upward or outer side of the valve is open to the air at all times, so that the valve is free at all times from any pressure of the out-going steam which escapes through the perforated casing into the open air without a disturbing noise. There is no back pressure in this valve, which opens to greater height than is usual in valves of this kind.

While the "straight Crosby" valve, as shown in Fig. 3, is designed for locomotive use, it will work equally well anywhere, but a less expensive form of valve particularly designed for stationary and marine boilers is also shown in Fig. 3. This valve is known as the Crosby-Meady valve and the interior mechanism consists

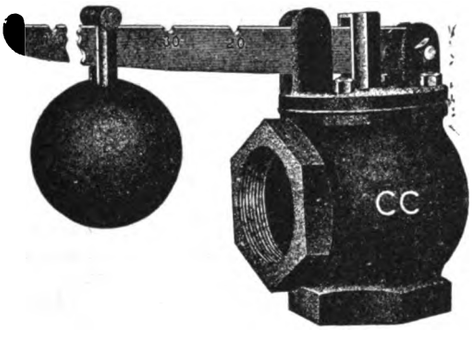



FIG. 1.—LEVER SAFETY VALVE.

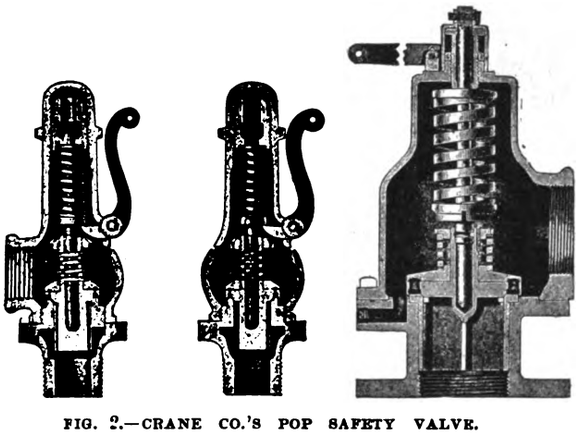


FIG. 2.—CRANE CO.'S POP SAFETY VALVE.

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of a central spindle, A, which has a slight annular enlargement of its lower end, and rests in a central cavity in the top of the valve, C, being held in place and centrally guided by a flanged nut, B, which is screwed down into the cavity until the flange of the nut rests on the top of the valve. By means of this device any outward movement of the lever lifts the valve, C, from its seat.

The valve, C, is provided with wing guides which fit smoothly into the cylindrical seating, D, upon the top of which the valve rests. The seats of this valve have an angle of forty-five degrees to the vertical axis.

On the outside of the valve seating (forming a part of it) is provided an annular flange, F, the top of which is on a plane with the bottom of the valve seat.

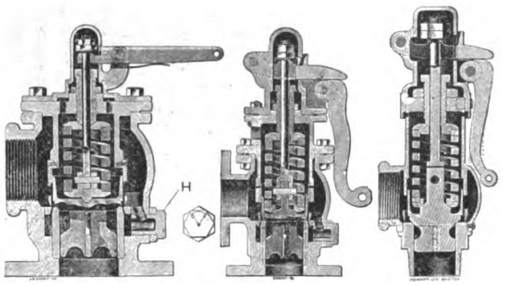


FIG. 4.—ASHTON POP SAFETY VALVES.

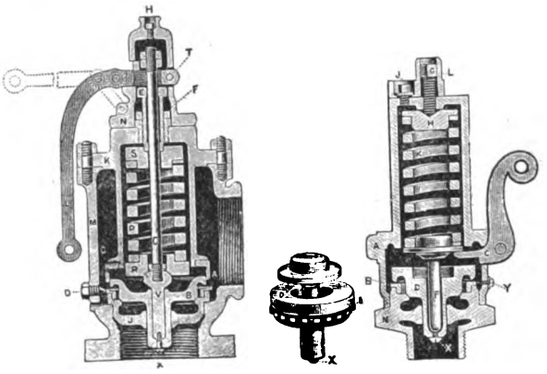


FIG. 6.—LUNKENHEIMER POP VALVE.

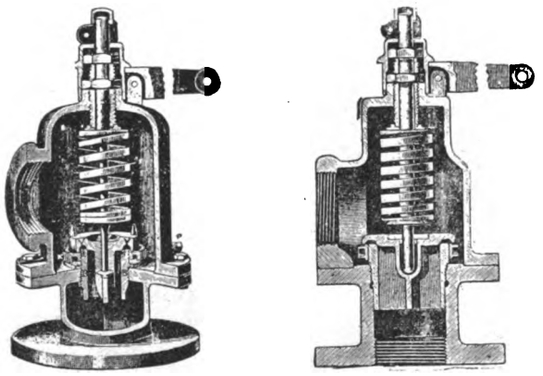


FIG. 5.—HAYDENSVILLE POP VALVE.

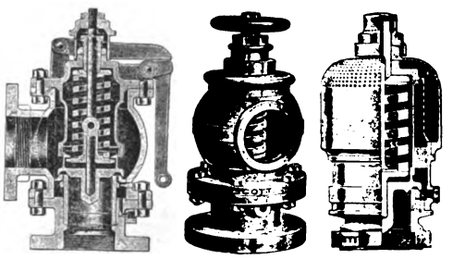


FIG. 7.—SCOTT SAFETY VALVE

Above the flange, F, the metal of the seating is cut away to form a right angle with the valve seat. The valve, C, is also provided with an annular lip, E, the external diameter of which corresponds with that of flange F of the seating. The under face of this lip, E, is also at right angle with the valve seat, and in combination with the seating forms a small chamber through which all the steam must pass to reach the open air—the greater part between the narrow edge of the lip, E, and the flange, F, of the casing, and the remainder through a number of small holes drilled vertically through the flange, F, to connect with this chamber.

Twin valves are made by this concern, the Crosby Steam Gage & Valve Company, Boston, Mass., and they also make special steam heating safety valves, which limit the pressure carried to 15 pounds per square inch. They also make high pressure valves for use when the pressure to be carried is between 500 and 5000 pounds per square inch.

Three types of valves, as made by the Ashton Valve Company, Boston, Mass., are shown by Fig. 4. The first represents the "Lock-Up" form, the second shows a cam lever marine valve, also with lock-up attachment. The third shows the yacht valve made by that company. In all these valves there is a chamber surrounded by a knife-edge lip and enclosed within the walls of this lip and the top of the bushing and valve seat. The knife edge wears down in proportion to the wear of the seat of the valve, thus keeping the outlet of the pop-chamber of the same relative proportion to the inlet, giving an unvarying pop and insuring long service without readjustment.

The supplementary pop chamber is introduced in all Ashton valves over two inches in diameter, and this chamber is connected with the primary pop chamber by a series of holes through the bushing. This arrangement serves the purpose of making a close regulation of the pop by the adjustment of its outlet passage into the discharge chamber by means of the screw plug regulator, H, on the outside of each valve. By adjusting this screw, which is so constructed as to be free from corrosion or any possible chance of sticking, any desired pop can be obtained, that is, the range of pressure between opening and closing can be adjusted as fine as possible.

All these valves above two inches in diameter are fitted with a blow-back head, which forms a chamber enclosing the spring and protecting it from the great volume of steam. Both the inlet and outlet are on the base casting, making it possible to take the valve apart and regrind or otherwise repair it without breaking the connection with boiler or outlet pipe. Testing clamps are furnished wherewith a valve can be locked during a pressure test of the boilers, thereby avoiding the otherwise necessary changing of the blow-off point, and preventing an undue strain on the spring during such test.

From an inspection of the engravings above and hereafter shown, it will be seen that the principle upon which the quick action of the pop safety valve depends is that of reaction. The issuing steam strikes against a lip of the main valve, or against a supplementary ring attached thereto and effects much the same action that is brought to pass when a stream of water strikes the current surface of a turbine bucket. The reactive effect serves to open the valve further, and as the pressure diminishes, to close it quicker when action takes place either way.

Fig. 5 represents two forms of pop valve made by the Haydensville Manufacturing Company, New York City.

In both these valves the form of disc given to produce the reaction effect can be plainly seen, although the form of construction differs some in the two valves, that at the left hand showing a solid nickel seated form, while the other represents the ordinary brass-seated valve. The latter has only a limited adjustment of the screw ring under the reaction lips or knife edge, whereby wear may be compensated for and the degree of pop, or "pounds of waste," kept within bounds, say, within two or three pounds.

The forms of pop valves illustrated by Fig. 6 are made by the Lunkenheimer Company, Cincinnati, Ohio, and present some interesting features in modern

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safety valve engineering. Two forms of valve are shown, the iron body and the brass form of construction. The pop, on action of the escaping steam, is controlled by the externally threaded ring, B, in the base of the valve, which is easily accessible without taking valve apart, and is held securely in place when set by means of set-screw, Y, on the side of the valve body. If the valve pops suddenly and does not reduce the pressure enough, turn ring B down (further away from the valve disc), and if it pops too much, opening and closing only gradually, turn ring B up (nearer to the valve disc). When the desired adjustment is obtained, secure the ring by means of the set-screw.

In the iron body valve it will be noticed that it is not necessary to change the pressure adjustment when testing the boiler, as the lock screw, H, can be removed and a long set screw of the same size inserted and screwed down upon the valve stem holding disc to its seat while pressure is being applied to boiler. As soon as test is over the set screw can be removed and valve will again be as efficient as ever. The spring and disc are encased and action of valve cannot be effected by back pressure, in case discharge pipe is cramped or muffled.

The three forms of safety valves illustrated by Fig. 7 are known as "Scott" valves, and are made by the Roe Stephens Manufacturing Company, Detroit, Mich. The first cut in the engraving shows their form of marine lock-up pop valve as accepted by the U. S. Government on a basis of one square inch of valve area for two square feet of grate surface. This valve has the reaction form of disc with adjustable ring for changing the pop. The spring is isolated from the steam, and access can be had to the valve without interfering with the outlet pipe.

The second cut in the engraving shows an adjustment apparatus, where by the turning of a hand wheel, two adjustments of pressure may be had at will. Thus, the valve may be set at 90 and 200 pounds and by a turn of the hand wheel, shown at the top of the cut, may be made to work at either pressure at will. Thus, in boiler houses which require a lower pressure of steam in the day time than at night, these valves particularly apply as a simple turn of the hand wheel changes from one pressure to the other.

The third cut in Fig. 7 shows the Scott muffler valve, Richardson style. These valves are so constructed that it is impossible for them to cock or tilt, being guided by the wings at the bottom and a head at top, and nothing more than atmospheric pressure is retained on top valve, and when in operation it cannot be loaded. They are also provided with an adjustable screw threaded ring, by the use of which the point of closing can be easily regulated. The muffler valve is of similar construction to the plain valve, but is provided in addition with a perforated dome-shaped exterior casing with a new design of inside muffler, by which the noise of the escaping steam is lessened to a marked degree, and does not impair the efficiency of the valve, which will give perfect relief to the boiler.

Two types of pop valves as put upon the market by the Consolidated Safety Valve Company of New York are illustrated by Fig 8. The first is a thin nickel-plated valve, made with the Rich-

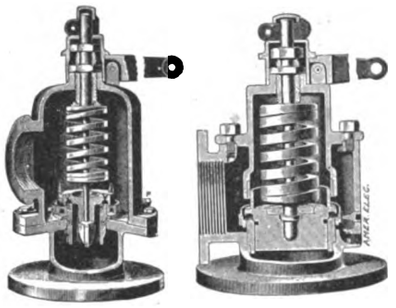


FIG. 8.—POPS OF THE CONSOLIDATED SAFETY VALVE CO.

ardson adjustable screw ring, as in fact are all the pop valves manufactured by this company. This style is supplied by that company at all times, unless some special form of valve is specified. The adjusting ring for regulating the pop, also the set screw for holding same in place, is plainly shown. In this valve the spring is placed directly in the blow-off chamber, consequently it is exposed at all times to action of the escaping steam. But in the second cut of Fig. 8, which shows the base-outlet pop valve made by this company, there is a separate compartment for the spring, which protects it from heat and moisture of the escaping steam. This valve is intended for large boilers in electric light plants, while the "Standard" is also adapted to the same service, but is not quite as high in grade as the second cut in Fig. 8. The latter, having a base outlet, i. e., an opening in the lower casting for its discharge, can be taken to pieces without breaking any pipe joints.

## A STORAGE TESTING BATTERY.

BY BENJ. H. GLOVER.

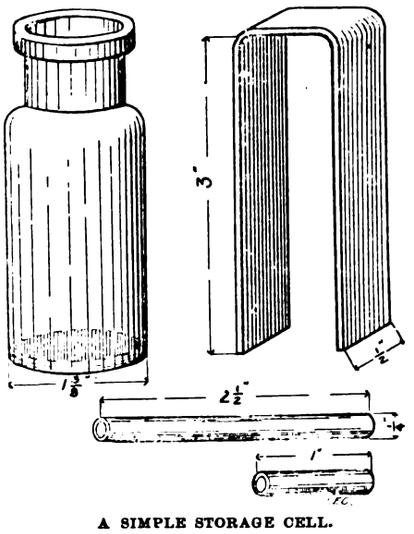
In making electrical measurements it is usually necessary to use some form of battery as a source of e. m. f. For ordinary bridge work a few cells of dry or sal-ammoniac batteries are sufficient and are usually on hand. There is, however, a large class of testing work where a considerable electromotive force is needed. A silver chloride battery of one hundred cells or more is an expensive piece of apparatus and is also a frail affair. It must be used with caution and is liable to be rendered almost worthless by an accidental short circuit or the making of wrong connections.

Having considerable use for a high e. m. f. in various testing work, the writer devised and constructed a storage battery which was not only compact and convenient, but thoroughly reliable and practically indestructible if given ordinary care and attention. The results being so satisfactory, several batteries have since been built along the same lines by those who have examined it, and no doubt the following description will be of value to any who have occasion to use such apparatus or wish to construct a similar battery.

The containing jar consists of a one-ounce wide bottle. This bottle is three inches high and one and one-quarter inches outside diameter, with an opening of three-quarters of an inch clear. The elements are made of sheet lead strips one-half inch wide, seven inches long and one-sixteenth inch thick. Such a strip is bent as indicated in the sketch and forms two elements: the positive of one cell and the negative of the adjoining cell. The two elements in one cell are separated and insulated by two pieces of glass tubing. This tubing has an outside diameter of one-quarter inch. One of the pieces is two and the other one inch in length. The longer tube is used as a filling funnel for the electrolyte and as a separator for the strips. The short piece of tubing serves as a vent for air when filling the bottles and for gases when charging.

In constructing a cell two strips properly bent in shape are separated by the glass strips and a rubber elastic band is snapped over the whole. This keeps the parts together while the cell is being sealed. Some of the regular wax used by storage battery companies should be used for this purpose, as it is not affected by the acid. Considerable difficulty was experienced with the first cells made, due to the fact that common wax was used, which was attacked by the acid, and held a quantity of moisture, which caused the cells to leak and run down rapidly when left on open circuit.

If the bottles are filled up to the neck with some heavy liquid the wax may be




A SIMPLE STORAGE CELL.

flowed about the strips, making an effective seal. Another method, though more laborious, is to place small lumps of the wax around the strips and then seal with a blowpipe.

After sealing the cells into groups of any desired number and arrangement they should be filled with an electrolyte com-

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posed of sulphuric acid and water with a gravity of about 22 degrees Beaume.

The forming of the active material on the plates takes some time, but should be carefully performed, as the more satisfactory results obtained fully compensate for the care and patience exercised. The area of the active surface exposed to the electrolyte is about one square inch. When forming the plates at least two 110-volt lamps should be placed in series when charging from 100-volt mains. Every hour or two the battery should be discharged through the same resistance until nearly exhausted and then recharged as before. This operation must be repeated and continued until the plates are well formed, cutting down the charging current to one twentieth of an ampere as the process advances.

As to the cost, a 50-cell battery was built from the following inexpensive materials:

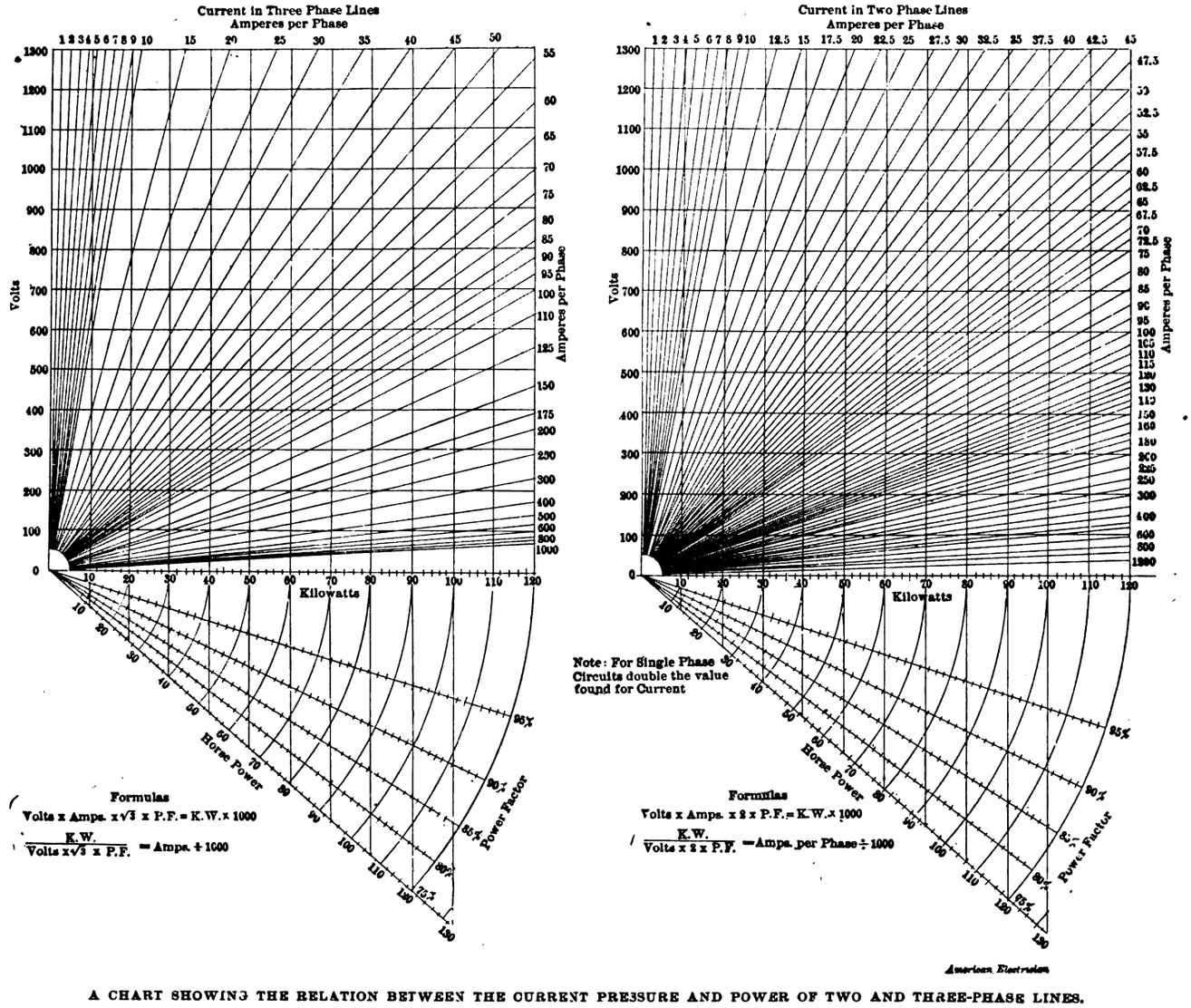
| | |
|---|---|
| 50 one ounce wide mouth bottles | $ .50 |
| 8 pounds lead (7 in. x 36 in. x 1/16 in.) | .48 |
| 1 pound glass tubing (¼ in.) | .30 |
| ½ pound wax | .10 |
| 1 pint acid (concentrated) | .25 |
| | $1.63 |

## A CHART FOR DETERMINING THE CURRENT IN TWO AND THREE-PHASE LINES.

The determination of the current in the wires of two or three-phase lines for a given number of kilowatts or horse power with a given voltage and power factor requires considerable calculation from the proper formulae, all of which can be readily replaced by the scales printed below. Of these the right hand drawing gives the values for two-phase lines, and by multiplying by two gives the current strength for the same conditions on single-phase lines, while the left hand scale gives the current for three-phase lines. The formulae from which they were drawn are given with them. The directions for their use are as follows:

To find the current per phase for any output at any voltage, look up the vertical line corresponding to that output in kilowatts as determined by the horizontal scale running along the base of the intersecting squares. Follow this vertical line up to its intersection with the horizontal line corresponding to the voltage of the circuit and the current strength in amperes will be found at the end of the diagonal current line intersecting that point. For example, upon the two-phase chart 50 kilowatts at 1100 volts shows approximately 22½ amperes per phase. In case the circuit is single-phase the number of amperes for this load at this voltage would be 45. If no diagonal line passes through the point of intersection the value of the current may be found by interpolation between the diagonal lines next above and below. For example, 70 kilowatts at 900 volts shows a current strength midway between 37½ and 40 amperes, or about 38¾ amperes. By noting the position of the decimal point any current at any voltage may be determined. For example, to determine the current at 2200 volts for a given load the current at 220 volts may be read off from the chart and divided by 10; similarly, to determine the current for 500 kilowatts. 50 kilowatts may be applied to the chart and the result multiplied by 10.

If the load is given in horse power instead of kilowatts, it may be followed up




A CHART SHOWING THE RELATION BETWEEN THE CURRENT PRESSURE AND POWER OF TWO AND THREE-PHASE LINES.

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vertically from the scale on the lowest radial line. For eexample, 80 horse power at 600 volts gives 50 amperes. The other radii are for use in case the power factor is less than unity. In this case the kilowatt line should be followed down vertically to its intersection with the radius representing the power factor of the circuit, and the circle intersecting this point should be traced around to the vertical and carried up into the scale of volts and kilowatts. For example, 70 kilowatts with a power factor of 80 per cent. shows an apparent load of 88 kilowatts, which may be followed up to—let us say—1100 volts, giving 40 amperes.

By combining these various methods a given number of horse power with a given power factor may be reduced to current. For example, 106 horse power followed up vertically shows 80 kilowatts, which, with an 80 per cent. power factor, shows 100 apparent kilowatts and a current dependent upon the voltage as above pointed out. The chart is also reversible, a given number of amperes at a given voltage being readily reducible to kilowatts and horse power if the power factor is known. For example, 70 amperes at 300 volts is evidently 43 kilowatts, or 56 horse power, if it is non-inductive. If it has a power factor of 90 per cent., the same number of amperes at the same voltage becomes 39 kilowatts or 52 horse power. The same methods are exactly applicable to the right hand scale of three-phase systems.

The lower diagonal or radial lines may be used to represent the efficiency of a motor in place of the power factor; e. g., a 90 kw. motor having an efficiency of 90% would require 100 kw. to drive it and the current required can be found as above.

These charts were drawn up by Mr. Stephen Q Hayes, to whom the readers of the American Electrician are indebted for their publication.

## Letters on Practical Subjects

### An Improvement in Coherer Construction.

*To the Editor of American Electrician:*

Sir—I have read with considerable interest the article by Prof. Jerome J. Green on wireless telegraphy in the July issue of the American Electrician. The form of coherer and tapper shown in Fig. 4 is an exceedingly desirable and compact arrangement and simply constructed from existing materials. There is, however, more in the device than seems to have been mentioned in the article, and I venture to make the suggestion that if the shell or dome of the buzzer were made of a steel or iron casting, a great deal of trouble due to waves emanating from the vibrating contact of the tapper would be eliminated. In such a form the device would be an attractive and useful piece of physical apparatus and in due time of commercial value; in short, it seems to me that Prof. Green's coherer and tapper suggest a very desirable standard form for the apparatus.

GEORGE T. HANCHETT.

New York, July 17, 1899.

### A Name for the Self-Propelled Vehicle.

*To the Editor of American Electrician.*

Sir—The mechanical or self-propelled vehicle for use on streets is drawing so much public attention and meeting with approval and demand so rapidly that it seems strange that no satisfactory name has as yet been given these vehicles, and as this question is one that has come up recently in some of the papers, I have taken the idea under consideration, and I believe, finally solved the problem.

To such vehicles the name horseless carriage, automobile, motor vehicle, electric carriage, auto-car, electro-mobile, gasolene wagon, etc., cannot be used when speaking of the operator and retain the name of the vehicle, or distinguish the sex of the operator, or in fact, distinguish the operator at all, let alone any distinction of the act of running such a vehicle. What is required is a name that in speaking of an operator of either sex or the act of driving, will carry with it the name of the vehicle itself, and also a name broad enough in its application to apply to any form of self-propelled vehicle, whether electric, gasolene, steam or any other form of motive power.

The name I wish to suggest to the public is a name which fulfills all of these requirements, and that is the name AUTOBAINE, which, translated, means automatic wagon, BAINE, being derived from an old Greek word, meaning wagon; so we have for the name of the vehicle, AUTOBAINE. AUTOBAINEER, as applied to a man operator, AUTOBAINEESS, as applied to a woman operator, and AUTOBAINING or AUTOBAINEERING for the act of using the vehicle, in addition to which this name is applicable to any kind or form of self-propelled vehicle.

C. E. WOODS.

Chicago, Ill.

### Polyphase Generators, Transformers and Motors.

*To the Editor of American Electrician:*

Sir—I notice in a recent issue of one of your contemporaries an article on the above topics, in which considerable space is devoted to a description of polyphase transformers. Four types are mentioned, as follows: "Two-phased transformers, which simply raise or lower the potential; three-phased transformers, which act similarly; two-phased-three-phased transformers, which receive two-phased currents and deliver three-phased currents, at the same potential, or higher or lower, as the case may require; and three-phased-two-phased transformers which receive three phases and deliver two, at even potential, or higher or lower potential."

In the plant with which I am connected polyphase apparatus is used, but entirely with single-phase transformers; the latter are also used to transform from two phases to three phases and vice versa. I have always understood that this was universal practice in this country and have never heard of any plant in which polyphase transformers were used. If such instruments are in use I should like to see descriptions of them in your columns.

The same article advises engineers that "good practice as applied to revolving armature machines of either two or three phases is to use 1000 volts or less at the machine, step-up transformers at the switchboard to raise the pressure to 2000, 3000, 5000 or 10,000 volts, according to outside conditions." If this is the case universal practice in this country on 2000-volt systems, which are now standard for alternating central stations, must be bad, since the 2000 volts are universally, one may say, generated directly in the machines, whether they have revolving armatures or revolving fields.

I noticed also another slight departure from actual facts, to which I call attention only to emphasize the arraignment made below, and that is the statement in the same article that synchronous motors must have brushes and collector rings. In my own plant we use an inductor machine as a synchronous motor and it has, of course, neither brushes nor collector rings.

It would seen to me that publications such as the one referred to, which has recently commenced dabbling in electrical affairs and which aims to give elementary instruction to practical men, should be careful that these instructions conform with the conditions of practical work.

A. R. B.

Niagara Falls, New York.

[The statements of the writer given above are correct. No polyphase transformers are commercially used in any instance in this country, although they are to a limited extent on three-phase plants in Europe. The generation of 2000 volts in revolving armature machines is common and good practice, and synchronous motors—if of the inductor type—require no brushes or collector rings.—Editor.]

### The Value of Feed-Water Heaters.

*To the Editor of American Electrician:*

Sir—In a paper which is abstracted in your issue of July, 1899, entitled "A Local Transmission System," certain reasons have been set forth as to why "the Union Station was designed and equipped with all auxiliaries electrically operated, the steam from the boilers being used only in the main engine."

The deductions will not hold, either in theory or in practice, if feed-water heaters are considered for the service. A conservative and perfectly safe estimate of the difference between running everything condensing and running a sufficient

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part of the plant non-condensing to supply the exhaust steam necessary to heat the feed-water up to say 210°, can be readily made.

Let us assume the case of a plant developing with one or several large units 5000 i.h.p., with auxiliaries belt-driven, or electrically operated (though the belt-driven is the more economical) doing this work on a consumption of 15 lbs. of steam per h. p. per hour. Then 75,000 lbs. of water will have to be made into steam per hour, from water from a hot well, at say 100° F.

Against this let us compare another plant, doing the same amount of work with one engine of say 500 h. p., run non-condensing, and the rest of the engines (4500 h. p.) operating condensing. With the same steam consumption the condensing engines will require 67,500 lbs. of steam per hour; if the non-condensing engine will require one-third more steam per h. p. than the condensing engine, it would be a very liberal estimate. On this basis the 500 h. p. non-condensing engine will require 10,000 lbs. of steam per hour. Total amount of heat required per hour for this plant would then be that for 77,500 lbs. of steam, less the heat conserved from the exhaust from that non-condensing engine. If we take the most extravagant estimate of the losses from work done, radiation, etc., at 25% of the total amount of the heat in the steam used by this non-condensing engine, we could still save 75% of the heat in the steam, or the equivalent of 7500 lbs. of steam, for about this quantity would be needed to raise the temperature of the hot well water from 100° (the same temperature as in the other case) up to the boiling point.

Deducting this from the gross total of 77,500 lbs. gives the net total of heat required for generating steam as the equivalent of 70,000 lbs. per hour. That is, instead of having to burn coal for evaporating 75,000 lbs. of water per hour, it will only be necessary to burn the coal required to evaporate 70,000 lbs. of water per hour; the difference is 5,000 lbs. in favor of running the auxiliaries with steam.

The equipment required for running the auxiliaries by steam costs considerably less than the other, and the saving will be in the neighborhood (under the actual conditions) of 8% of the total fuel bill.

The plain truth of the matter is that unless the temperature of the feed-water entering the boilers is 200° or over, no one can afford to run any auxiliary condensing, direct-driven, or with a motor. The exceptions to this general statement only prove the rule.

The 5000-h. p. plant which we suggested will stand the most careful investigation, and the only point that can be made against it—granting that good practice requires boilers to be fed with hot water—is whether it is better to use economizers or feed-water heaters, as suggested. Both heaters and economizers utilize waste products; if either one will supply all the heat that can be conserved there is no need of utilizing the other.

In favor of the above plan, if with it the open heater is used, there is a less first cost of installation, a less cost for upkeep, no deterioration of the heating qualities, and a certain amount of purification for the feed supply. The heating results given are practically the same, so that when you come down to it one can better get along without an economizer than he can without a properly designed open feed-water heater.

Many engineers are of the opinion that because steam auxiliaries require a great many more pounds of steam per horse power per hour for their operation than the same power can be developed in a condensing engine, that they are wasteful and should not be used. These people are the ones we wish to enlighten.

The actual heat taken from steam for work done is, of course, exactly the same in all engines, roughly, 43 heat units per minute per horse power. Even supposing that steam auxiliaries require 150 lbs. of steam per horse power per hour, 95% of the heat in this steam can, we believe, be used in a heater for heating the feed-water, since 5% will more than account for the work done and for radiation. It must not be overlooked that even with engines taking steam practically the full length of the stroke all of the initial condensation will be re-evaporated, because the sudden fall in pressure, when the exhaust valve is opened to atmospheric pressure, will liberate enough heat for this re-evaporation.

J. C. JONES.

## Electrical Catechism

*322. What are the fundamental principles upon which the electric motor operates?*

Every current is surrounded by a magnetic field of force which distorts any other magnetic field in the vicinity; the two combine into a resultant field whose lines of force tend to become as short as possible, thereby tending to move both sources to a new arrangement such that the lines may be as short as possible. In accomplishing this result, what is called the "field" is usually the space between the poles of an electromagnet; the current is in wires carried on or near the surface of a cylinder of laminated iron, the combination of iron and wire being called the "armature."

*323. Are alternating current motors based upon the same principles as those for direct currents?*

The fundamental principles are the same, although in the application there are many differences. With direct current motors the currents for both the field and the armature are taken from the external circuit; with most of the motors for alternating currents the field is magnetized by current taken from the external circuit, while the current in what corresponds to the armature is usually obtained by induction.

*324. Will an alternating current motor work upon a direct current circuit?*

A few small a. c. motors will work on a direct current, but most of the larger ones will not.

*325. Will a direct current motor work upon an alternating current?*

Almost any d. c. motor will run when an alternating current is sent through it; but it will not ordinarily develop any considerable amount of power, unless wound specially for the purpose and unless the field magnets are made of laminated iron and precautions are taken to avoid induced currents in stationary parts of the motor.

*326. What kind of motor is the easiest to understand?*

Perhaps the simplest is the "oblique approach" motors made for toys or small sizes only. These must usually be started by hand. The moving and stationary parts are both magnetized by the same coil, and are so designed that the path of the magnetic lines of force becomes shorter and shorter as the armature revolves until it reaches the shortest path, when the current is cut off for a short time and the attraction ceases until the momentum has carried the armature past. Figs. 1 and 2 illustrate the principle involved. Suppose that the armature is in the position shown in Fig. 1, when current is sent through the coil around the pivoted piece N-S. The current sets up magnetic lines which extend through the iron circuit somewhat in the direction shown by the dotted lines. The tendency of these lines to shorten draws the movable piece around to the position shown in Fig. 2. It would stop here, because in this position the air gap is shorter than in any other position; but a commutator is arranged so that the current is cut off at this point and the moving piece keeps on moving by its own momentum, until it reaches a position one-quarter turn ahead of the position shown in Fig. 1, when

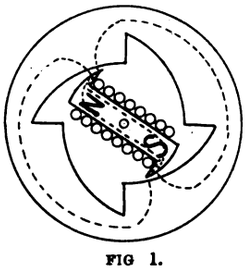


FIG 1.

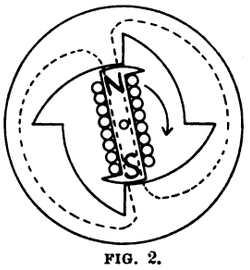


FIG. 2.

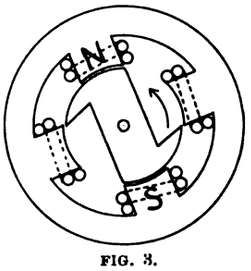


FIG. 3.

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current is again sent through the coil and the pivoted piece moves on again through a similar set of changes. Some motors of this type have the coils on the stationary part; which has usually more than one pair of coils and poles, the current going first through one pair and then through the other, as suggested in the third figure.

*327. In the "oblique approach" motors, which part is the armature and which the field?*

Ordinarily the moving part would be called the armature, and the stationary part the field. This is easy to see in Fig. 3, but there is room for discussion regarding the motor shown in Figs. 1 and 2.

*328. What class of motors is easiest to understand next?*

Those in which the moving part has two or more projecting ends like those on the armatures of the "oblique approach" motors, but whose field magnet and armature have separate coils. Examples of these are shown in the accompanying figures. The simpler one is the "Edison" toy motor, Fig. 4, whose field is a sort of horseshoe magnet, and whose armature is the shape of the capital letter I or H. The two ends of the coil upon the armature are connected respectively to the halves of a split sleeve, which is carried upon the shaft and upon which two stationary brushes rub; it is evident that if these brushes are set properly, one brush will press against one part of the sleeve for one-half a revolution of the armature, and upon the other part of the sleeve during the remainder of the revolution. If current is sent through the motor when the armature is in the position shown in the figure, the magnetic lines of force will pass through the circuit and in shortening will draw the armature to the horizontal position; now, if the brushes have been arranged properly, the commutator will have turned around far enough so that each brush presses against a different bar and the current, goes through the armature in the opposite direction; the armature and field now repel instead of attract, and when the momentum has carried the armature past the dead center it will be attracted in the other direction, and so the rotation will continue.

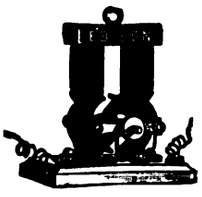


FIG. 4.

*329. How does the "Porter" motor operate?*

This motor, which is shown in Fig. 5, has three poles in its armature. The commutator likewise is in three sections. The brushes are placed diametrically opposite, so that they press against only two of the segments most of the time. Current is sent through the two poles which are in the position to pull the hardest, and when one pole gets to the dead position, where it tends to stay, current is cut off from it and sent into another pole. This motor has no dead center, and will start in any position.

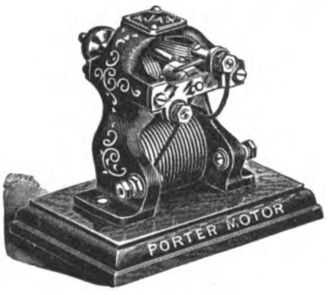



FIG. 5.

*330. How are the armatures of larger motors made?*

The iron core is in the shape of a cylinder having wire wound over its entire surface, or in grooves upon the surface; the wire is wound in sections, which are connected in series with each other, and are connected with the successive bars of a commutator. A "smooth core" armature has the wire upon the surface, while a "toothed," "slotted" or "tunnel wound" armature has the wires in slots or in holes just below the surface. Fig. 6 shows the external appearance of a smooth core armature, while Fig. 7 shows the commutator.

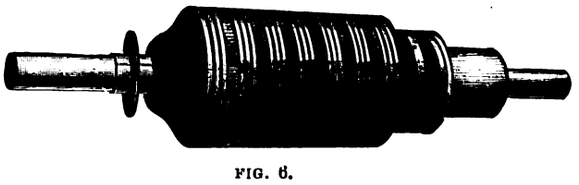


FIG. 6.

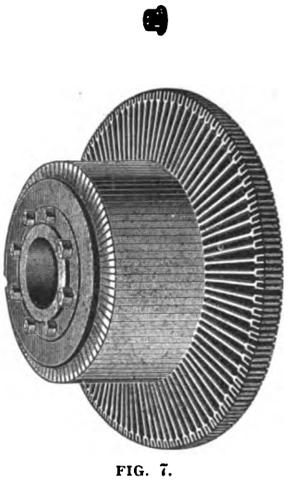


FIG. 7.

*331. What causes a surface wound armature to rotate when current passes?*

The armature is in a strong magnetic field which becomes distorted more or less by the magnetic effect of the current in each of the wires on the surface. The action of each wire may be considered as something like that shown in Fig. 9, where there is a strong pull tending to move the wire in between the poles of the magnet. In the case of the actual armature, the lines of force would naturally go into the armature by the shortest path through the air; that is, would go radially. But the magnetic force about the current deflects the lines and makes them traverse a longer path, somewhat as indicated in Fig. 8, in which circles represent wires, current going toward the paper in those with crosses and toward the observer in those with dots. The effort of the lines to shorten causes the wires to move in the direction indicated by the arrows and thus rotate the iron armature core to which they are fastened. As the wires move to such position that they would pull in the opposite direction, the commutator sections to which they are connected pass under the brushes, and the current is reversed and they still pull in the same general direction.

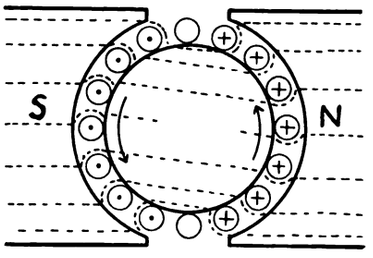



FIG. 8.

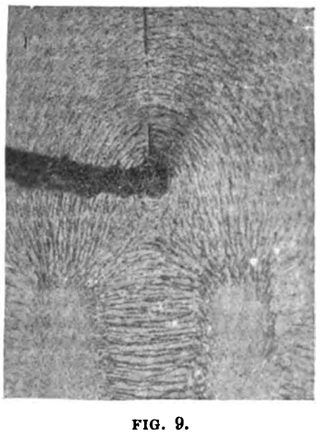


FIG. 9.

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# Queries and Answers

What voltage is there between the points of the two carbons in the leading types of enclosed arc lamps for use on 110 volt direct current circuits? H. A. M.

80 to 85 volts.

I have a standard Western Union 150-ohm relay which I wish to rewind to 20 ohms. Please let me know what size wire would be needed to wind the coils to that resistance. H. S. K.

About No. 25 wire would be best for that purpose.

Please be kind enough to tell me the ratio of difference between copper and platinum wires of the same diameters. C. S. W.

Platinum wire has about 5 2/3 times the resistance of copper wire.

The main Western Union lead is built north and south on east side of a street. A home telephone company with a heavy lead (8 ten-pin arms) is built directly over on same line with some copper metallic, but generally common return, on which they have endeavored to prevent grounds. Primary wire from 2000 volt alternator passes between the two leads, cutting their line at right angles and extending east 10 ft., where a transformer is located on pole. There is four feet of clearance on both leads. Would that increase lightning hazard and why? We have lost two transformers, while no trouble has been experienced on southwest corner under Postal main lines. E. R.

With the clearance mentioned it is difficult to see how the existence of telephone and telegraph leads can possibly increase the lightning risk on the lighting wires.

What is the proper length of air gap for a swinging ball lightning arrester on a 110 volt circuit? J. H. D.

The air gap should be made very short with this low voltage, as there is no danger of the current jumping. About 1/32 of an inch is suitable. The length of the gap must be increased for high pressures, especially those of many thousand volts.

What temperature centigrade is given in an electric furnace such as is used in the manufacture of calcium carbide, and what is the temperature at the electrodes of a 2000 c. p. arc lamp, consuming practically 10 amperes of current? C. H. M.

The temperature of either 7 or 10 ampere arc lamps is practically that of the melting point of carbon, which has been estimated at 3500° C. That of the calcium carbide furnace is probably somewhat less as the carbons are not melted.

(1) What would be the proper dimensions of a good common medical coil and what amount and size of wire for primary and secondary?

(2) What size or strength of motor will it take to run a common sewing machine?

(3) I have a 16 light 110 volt dynamo, shunt armature, wound with No. 17 wire, 4 lbs. What amperage will it give at full speed?

(4) Can you give me the address of any one charging storage batteries by wind power in a small way, say about 2 h. p., and are they a success in every way? D. W. M.

(1) 2 ins. in diameter by 4 ins. in length. Primary ½ lb. of No. 12 wire. Secondary 1 lb. of No. 24 wire. (2) A 1/12th h. p. or a 12-in. fan motor will do the work. (3) 10 amperes. (4) This is not being done commercially and is a very difficult thing to do successfully.

I have a telephone line from station to office, length about two miles. It is strung on the poles of our 2200 volt a. c. circuit with frequent transpositions, but the line is very noisy. Would it reduce the noise to join the two wires of the circuit together at each end, thus placing the two wires in parallel, and connect the instruments between the ground and the overhead line? My theory is that the induced currents will simply flow backward and forward around the line and not affect the instruments much. F. C.

The trouble would probably be increased as the inductive effect of the circuit consisting of the overhead wires and the ground would be greater than that of a circuit between the two wires. The trouble could be largely reduced by putting in a repeating coil at each end of the line.

How can I find the proper size of wire for the three-wire system? C. S. R.

The positive and negative conductors should be ¼ of the size for the same percentage drop with the same load on the two-wire systems, i. e. calculate your wire by ordinary wiring tables for 110 volts for the total number of lamps and then choose a size with ¼ the circular mils found. The neutral should be the same size as the other conductors.

(1) Is there a device on the market for transforming the current from a 110 volt direct current circuit so that it can be used instead of batteries on telephone systems?

(2) On Edison three-wire systems will an ammeter indicate correctly if placed on lead from dynamo which connects to neutral bus? J. L.

(1) Yes, small motor dynamos with single armatures and two commutators are made for this purpose by several makers, notably the Crocker-Wheeler Electric Company, New York City, and the Holtzer-Cabot Electric Company, Boston, Mass. (2) Yes, the ammeter will indicate the load of the dynamo to which it is connected.

(1) If a high tension arc circuit were to be opened at any point, how would the E, R and C be affected?

(2) If a generator for such service were to be instantly short-circuited, what would be the action of E, R, C?

(3) If any electrical conductor could be extended to both sides of an arc circuit, thus cutting out a given number of lamps, how would E, R and C be affected?

(4) In operating an alternating arc lamp is resistance on one side of the circuit sufficient?

(5) If one ampere is to be received at a pressure of 100 volts, the distance being one thousand feet from the power generator and two volts are to be lost in transmission, what must be the total resistance of the positive and negative wires minus the resistance of the lamp? L. D.

(1) The resistance would rise to an infinite value and the current would fall to zero. The electromotive force would, for an instant, rise considerably, owing to the effort of the machine to regulate for the increased resistance, combined with the self-inductive kick of the fields. (2) The instant after short-circuiting such a machine the current would rise somewhat, but would be choked back by the armature reaction. As soon as the regulator could shift the brushes or vary the field resistance this rise would be corrected. (3) At the instant of cutting out the lamps there would be the same effect as under (2), but to a smaller extent. (4) Yes. (5) 2 ohms.

Can the rectifier described in the June issue of the American Electrician be changed so as to render it a satisfactory direct current generator or motor for 110 volt circuits, at a speed of 1200 r. p. m.? If so, what changes will be necessary? What is its power when used as an alternating current motor? B. E.

Yes. The machine will make a good 110 volt dynamo or motor if the following changes in the design are made:

The armature may be of the same general dimensions, but the number of slots should be increased to 16, making them 7/16 in. deep by 7/32 in. wide. The coils should preferably be form wound, of No. 27 double silk-covered wire, 3/16 in. square in section, and to cover 90° of the periphery of the core. Each slot will contain a half of two separate coils, the halves being placed one over the other. Each slot will then contain 200 conductors, each coil 100 turns, and when connected as a series wound armature, it will generate 110 volts at a speed of 1200 r. p. m.

The field may be of the same general form and dimensions as shown, but having its coils wound to size with No. 29 double silk-covered wire, instead of the wire indicated in the article. The coils will then have about 1500 turns each, and the shunt current will be almost exactly ¼ ampere. Allowance has been made for a rheostat in the field, which will increase the field current by 10 per cent. if necessary.

With the above winding the machine when running as a generator should carry two 16 c. p. 110-volt lamps without serious heating. And running as a shunt motor on the 110 volt mains its output would be somewhat more than ⅛ h. p.

The speed suggested of 1200 r. p. m. might be advantageously raised to 2400 r. p. m., a perfectly reasonable speed for so small a machine, unless there is some special reason for adopting a slow speed.

If 2400 r. p. m. be adopted the same armature winding outlined above could be connected as a parallel winding, and the output would now become about 2 amperes at 110 volts, that is, the machine would carry four 16 c. p. lamps, or would give about ¼ h. p. as a motor.

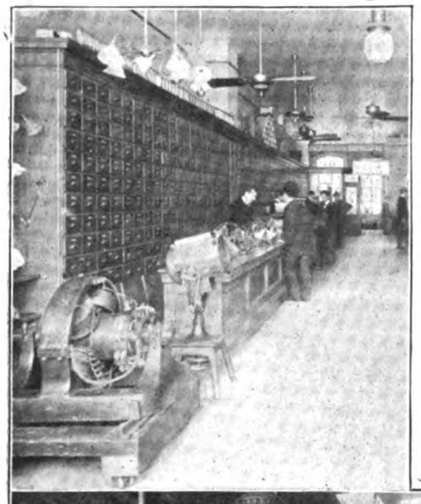
Incidental to changing over the design to that of a direct current generator or motor, the commutator could be reduced considerably in size, and the collector rings omitted, thus permitting the arms on the field casting to be shortened and so adding to the neat and compact appearance of the machine.

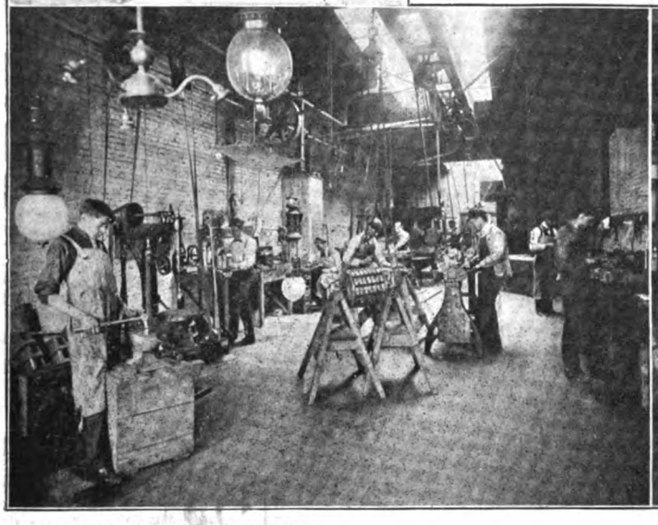
Brake tests made on the rectifier when running as a synchronous motor on the ternating current line show that it develops a little under 1/10 h. p.

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## AN ELECTRICAL SUPPLY HOUSE IN DETROIT, MICH

The Michigan Electric Company, whose new quarters are illustrated in this issue, began business March 1st, 1893, as electrical contractors for wiring and general construction.

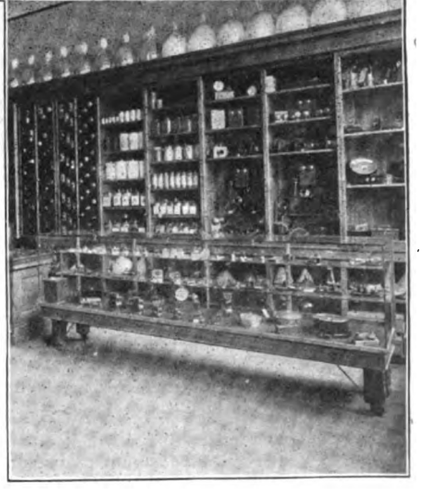




ONE SIDE OF THE SALESROOM.
SHOP ON FOURTH FLOOR.



STOCK AND
SHIPPING DEPARTMENT.



FIXTURES IN SALESROOM.

September 24th, 1898, its property was almost completely burned out by a fire of unknown origin, but undaunted, the company rented temporary quarters opposite the old location while the fire was still burning, and before the crowd had dispersed had temporary signs up, telephone in and business resumed. Fortunately the fire did not destroy any valuable records, so such a complete statement of the loss was immediately made out as enabled a settlement to be reached with the fire insurance companies the day that it was presented; this fact alone evidences the company's thorough and able management of business affairs.

The rebuilding of the old quarters having next been arranged for, President Joseph E. Lockwood visited the leading wholesale and retail electrical and hardware houses of the country and studied in detail their arrangements, fixtures and methods, with a view to securing in the new quarters the best possible combination to meet the requirements of the business and utilize to the fullest possibility the space available.

December 10th, 1898 (less than 90 days after the fire) the company moved back to the old location, which meanwhile had been entirely rebuilt from the ground up, excepting only the bare walls, and today it has one of the handsomest and most convenient quarters of all the general electrical houses in the country.

The business now covers everything in the electrical line including supplies and machinery, wholesale and retail, repairing electrical machinery and appliances, contracting for anything from installing a bell job on time and material, to furnishing and installing complete plants for light, power and railways. In addition the house has an experienced engineering force competent to handle every class of electrical work. It is manufacturers' agent for many of the leading electric specialties, such as Cutter switches, Western Electric fan motors, Atkinson's protected rail bonds, Creaghead overhead material and brackets, Chloride accumulators, Bryan Marsh incandescent lamps, etc., and for very large contracts represents the well known firm of J. G. White & Co., of New York. The company is also itself a manufacturer of electric and combination fixtures from both standard and special designs, of electric signs, decorative devices and other specialties.

The supply department occupies the first and third floors and basement. On the first floor is the general salesroom and supply department office.

The third floor is the receiving and shipping room and also provides space for part of the reserve stock. It is connected with all other floors by two power elevators (one passenger and one freight), and by a Sargeant hand-power package elevator, as well as by telephones and speaking tubes. The basement provides space for additional reserve stock and for tools of the construction department.

On the fourth floor is located the machine shop, which, with its plating, polishing, stock and tool rooms, is a complete factory in itself.

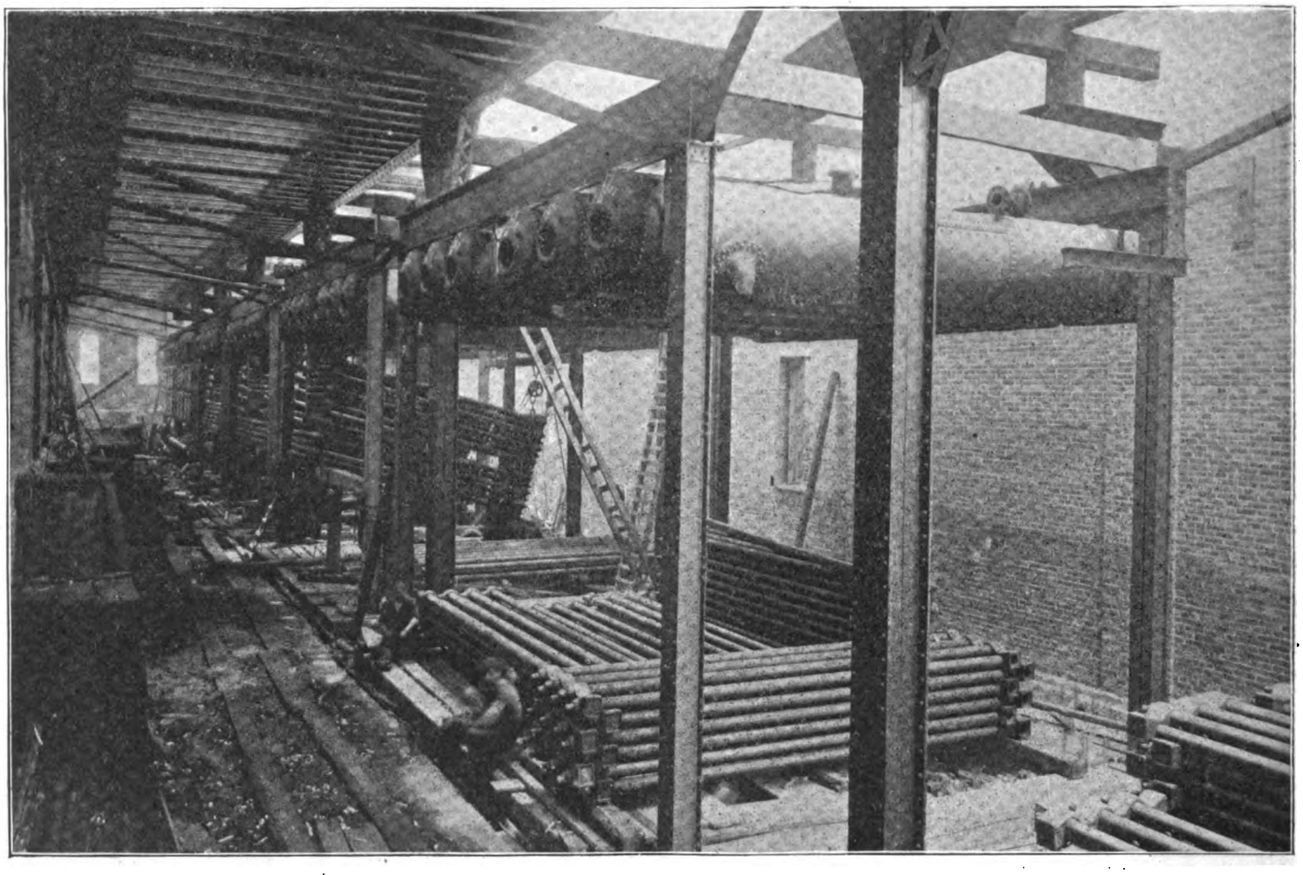
The lines along which the electrical business of the country will develop are of course matters of conjecture, some reading aright the signs of the times, to their profit; others the reverse. This firm believes that the bulk of the business of the country will not be secured by any one or two large centers of trade, but that it will be divided into natural sections in each of which the greater part of the business will go to whichever house is best located and adapted to meet its needs promptly and satisfactorily; believing this, the company has confined its efforts to, and has sought to provide for the needs of its section chiefly. The steady and rapid growth of its business during the depressed business period now passed is, it thinks, undisputable evidence of the correctness of its belief.

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## THE BOILER EQUIPMENT OF THE NEW POWER STATION OF THE CONSOLIDATED TRACTION COMPANY OF PITTSBURGH.

The new generating station which supplies power for a large part of the street railways in Pittsburgh has some unusual features in its boiler room, a view of which, while under construction, is shown in the accompanying illustration.

The equipment consists of six batteries of forged steel type sectional water tube boilers of special design made by the Babcock & Wilcox Company. Two boilers constitute a battery, and each battery is rated at 750 h. p. In order to economize floor space, these boilers are shorter and higher than the usual type. Each is made up with three 36-in. drums, 20 ft. long, and 18 sections of tubes, each 15 ft. long, giving about 4000 sq. ft. of heating surface. They are designed for a pressure of 200 lbs., and were tested under hydraulic pressure of 300 lbs. The fire boxes are equipped with the Hawley down draft furnaces, having a grate surface of 66 sq. ft. The furnaces are guaranteed to show 10 per cent. greater efficiency than the ordinary flat grate and to be able to burn 40 lbs. of coal per square foot of grate per hour, and to reduce the smoke by 92 per cent. The boilers with the Hawley furnaces are guaranteed to develop 75 per cent. efficiency with less than 1 per cent. of moisture at full load, or 1½ per cent. at 50 per cent. above rating. In tests which have been made the above guarantees have been attained. There are six unlined iron smoke stacks, one for each battery. Each stack is 66 ins. in diameter, and rises 147 ft. above the grate bars, giving a draft of 1 in. to 1½ ins. of water under ordinary conditions. The breechings and stacks are carried on special supports entirely independent of the brick boiler setting.



THE BOILERS OF THE CONSOLIDATED TRACTION COMPANY'S POWER HOUSE UNDER ERECTION.

## THE FEATURES OF A LINE OF MULTIPOLAR DYNAMOS AND MOTORS.

The field ring which also constitutes the frame of the machines illustrated on page 399, is made of three different materials for the different sizes. The two smaller sizes have field rings of wrought-iron, to which are bolted the eight radial poles. Wrought-iron was adopted for the small sizes, as it was impossible to get steel castings that were satisfactory from a mechanical as well as magnetic point of view. In the next five sizes the field rings are made of steel castings, which, for these sizes, leave little to be desired as regards magnetic qualities. To these rings the radial poles are bolted the same as in the smaller sizes.

For the three larger sizes of machines cast iron has been adopted for the field ring, as with steel or wrought iron the cross section necessary for magnetic purposes is so small compared with the linear dimensions that even if the frame had the necessary mechanical strength, it would present a very weak appearance, and besides be very unstable, on account of its great height and light weight. By the use of cast iron, stability is given to the machine, and at the same time the appearance for strength is greatly improved. Instead of bolting the poles to the ring, as in the case of wrought-iron or steel fields, the poles are cast-welded into the ring and are not removable.

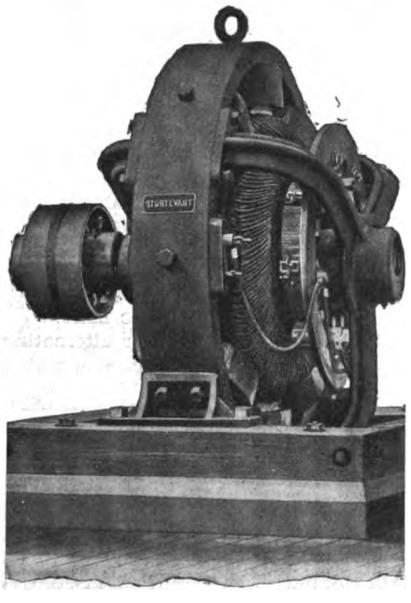
In all cases wrought-iron field cores are used, as this gives the highest efficiency in the field, giving a maximum magnetic field with a minimum weight of iron and copper.

One of the distinctive features of these eight-pole machines is the cast-iron pole shoe, which by its peculiar shape and size is one of the main elements which render these machines capable of extreme variation of load without sparking at brushes and without any shifting or adjustment whatever. On all sizes of machines which have the field cores bolted to the ring, these pole shoes are stud-riveted to the wrought-iron cores and constitute practically one piece. On those sizes in which the wrought-iron cores are cast-welded into a cast-iron field ring, the pole shoes are secured to the cores by means of set screws.

As these motors are designed with special reference to low speed and high efficiency, great difficulty has been experienced in arriving at a size of armature that would be favorable to high efficiency at partial loads, and at the same time

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allow room for the necessary amount of copper. The proportion of copper to iron must necessarily be great in order to keep the armature resistance at a reasonably



THE STURTEVANT M. P. 8 MOTOR.

low figure and provide for the necessary number of turns on the armature to produce the required low speed.

The two circuit winding is used in every case where possible, as this allows the use of larger wire and fewer turns, which not only makes the coils simpler and cheaper, but allows a greater weight of copper, due to the fact that less room is taken up by insulation. Aside from this in the two circuit winding each pole has only a fractional influence on the total e. m. f. generated, and consequently any eccentricity of the shaft with reference to the bore of the field, or any inequality of some of the field windings which would produce an unbalanced field, would not disturb seriously the electrical balance of the armature. The fact that as few as two sets of brushes can be used with this type of winding on machines of low speed and small output is an additional advantage.

Carbon brushes in reaction type holders are generally used and are supported upon a special rigging, which is, in turn, supported by brackets attached to the field ring. As these motors do not require any shifting of brushes from no load to full load, no elaborate device is provided for shifting or lifting brushes from commutator. The machines are made by the B. F. Sturtevant Company, Boston, Mass.

## PORCELAIN AND CLAY INSULATORS.

The making of porcelain is one of the oldest arts that has come down from prehistoric time. For many ages it was regarded as a lost art, but modern ingenuity has solved the mystery and to-day the making of porcelain wares for both table and ornamental purposes, as well as for electrical uses, is a growing business in this country. Not only porcelain, but some grades of native clay are suitable for insulating purposes, the latter being almost as valuable as the former, in fact, fully as good in insulating properties, but not so attractive in appearance.

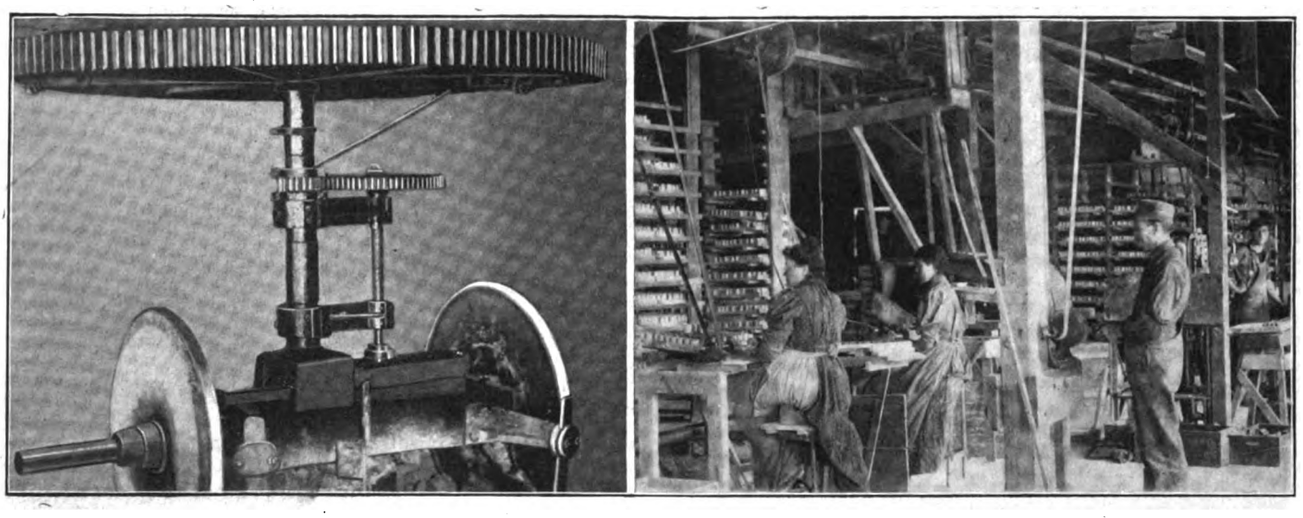
One of the extensive manufacturers of this class of goods is the Akron Smoking Pipe Company, whose works are located at Mogadore, Ohio. This company has control of clay deposits which are particularly adapted to the manufacture of insulating appliances, including special devices, such as switch bases, lamp socket parts or other forms which are designed to serve as non-conductors of electricity. The output includes tubes, ranging from 5/16 inches inside diameter to 2½ inches, and in length from 1 to 36 inches, as well as special shapes.

In the process of manufacture the clays are prepared by a washing process which removes all the foreign matter, including the iron oxides which are found in most clays and detrimental to the insulating qualities. After being washed the material is placed in what is known as a wet pan, which consists of a circular bed plate of iron with heavy wheels or mullers revolving upon it, and in this the material is pulverized and tempered until it receives adhesive qualities sufficient for molecular action to take place. It is now ready for the moulding process and is formed in dies or presses into electrical devices of all conceivable shapes and designs.

The forms after they are moulded are carefully placed on trays or dryers and placed on racks in the steam drying department, where they remain until all the moisture is evaporated, when the pieces are carefuly inspected or trimmed and finished and are passed on to the glazing department. After the pieces have been immersed in the glazing solution they are again dried and packed in seggers and made ready for the firing process. The seggers are cylindrical shaped forms, which are made in the works from the best of fire clay, and are manufactured on a pottery wheel, such as is employed for making ordinary stone ware. The object of their use is to protect the goods from the action of the flame in the process of baking, and being filled they are placed in tiers in kilns until they occupy the entire space.

The process of firing requires about seventy hours, during which time the contents of the kiln are raised to a heat of about 3600° F. This process fuses the silicates into the pores of the clay and also the glazing material, while it changes the chemical composition and produces the most durable substance known or found in nature. The kiln goes through a slow cooling process after the fires are withdrawn and the goods are not removed until the temperature is again normal.

It is a practice with the company to have samples of its goods frequently tested by the electricians of the Board of Fire Underwriters, and its cheapest grades of clays have stood the tests of immersion in water for 100 hours without absorbing more than 73/1000 of their weight of moisture. This, as will be noted, is well within the limit of 1 per cent., the limit allowed by the Board of Fire Underwriters.



SCENES IN THE MAKING OF PORCELAIN AND CLAY INSULATORS.

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# New Apparatus and Appliances

### AN INGENIOUS LOCKING DEVICE FOR MOTOR CONTROLLERS.

To provide a simple locking and releasing device for motor controllers which should hold the rheostat arm at any point, the Chicago Rheostat Company, Chicago, Ill., has designed the arrangement shown in Fig. 1. The releasing device consists

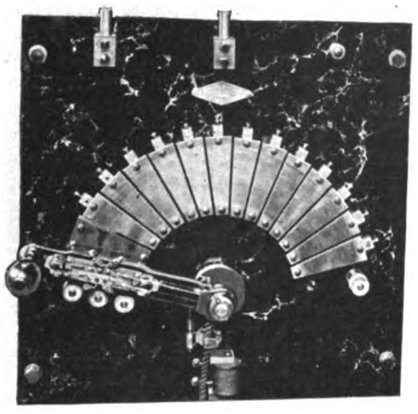


FIG. 1.—A MOTOR STARTER, WITH IMPROVED RELEASING DEVICE.

simply of a strap brake made up of a band of steel surrounding a small flange forming a part of the rheostat handle, one end of the band being fixed and the other attached to the armature of the releasing magnet. The latter, when energized, pulls up the strap of steel, gripping the pulley tightly and preventing the rheostat arm from turning toward the off position. When the voltage falls below a certain limit the magnet releases the armature and a small motion of the latter loosens the brake, leaving the rheostat arm free to respond to the spring, forcing it to the off position. The adjustment is such that the handle may be readily moved backward or forward over the contacts and yet is held firmly clamped on any desired contact, and resists successfully all jarring or vibrations tending to cause it to move from its position.

### A SIMPLE FORM OF LINE DISCHARGER.

For the protection of overhead lines the Stanley Electric Manufacturing Company, Pittsfield, Mass., has brought out a new type of discharger shown in Fig. 2. This consists of a spark gap which appears in the lower right hand side of the illustration, connected in series with a number of glass tubes filled with small metal balls about the size of bird shot. The resistance of these to ordinary voltages is very high, something over 50 megohms, but the disruptive discharges of lightning readily break across the contacts between the metal shot, much as do oscillatory currents across the contacts of a coherer, finding a ready path to ground, which, however, retains its resistance against ordinary pressures.

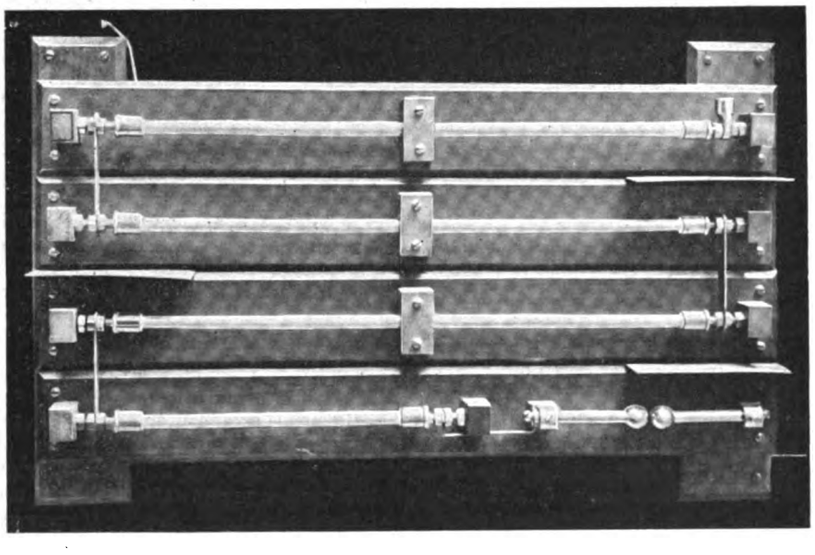


FIG. 2.—A LIGHTNING DISCHARGER FOR LINE USE

### THE HOYT DISCOUNT METER.

An indicator for giving the record of the maximum amount of current which has passed through it since its last setting, this purpose being the same as that of the Wright demand meter, is shown in Fig. 3. Unlike the Wright instrument, in which the indication is the result of the heating effect of the current, the Hoyt instrument is magnetic and mechanical in character.. A solenoid, which appears in the illustration just above the scale and below the wheel, attracts downwardly a plunger attached to a fine cord which passes around a drum fixed to the spindle of the wheel and index finger shown. From the right hand side of the periphery of the wheel another cord supports the piston of a dash pot, which piston also serves as a counterweight and force against which the magnetism set up by the solenoid must draw the plunger. The wheel is also fitted with a fine ratchet which engages with a light spring, serving as a pawl, which tends to hold it in the lowest position assumed by the plunger. When current passes through the instrument it draws down the plunger against the force of gravity on the dash pot piston, the deflection being proportional to the current. The apparatus is held at its point of maximum deflection by the ratchet, and sudden impulses of current are prevented from affecting it by means of the dash pot.

The meter is made by the Whitney Electrical Instrument Company, Penacook, N. H., under the patents of Mr. A. H. Hoyt, the company's general manager.

### PETITE ALTERNATING ARC LAMP.

The latest enclosed arc for alternating current circuits is that, one form of which

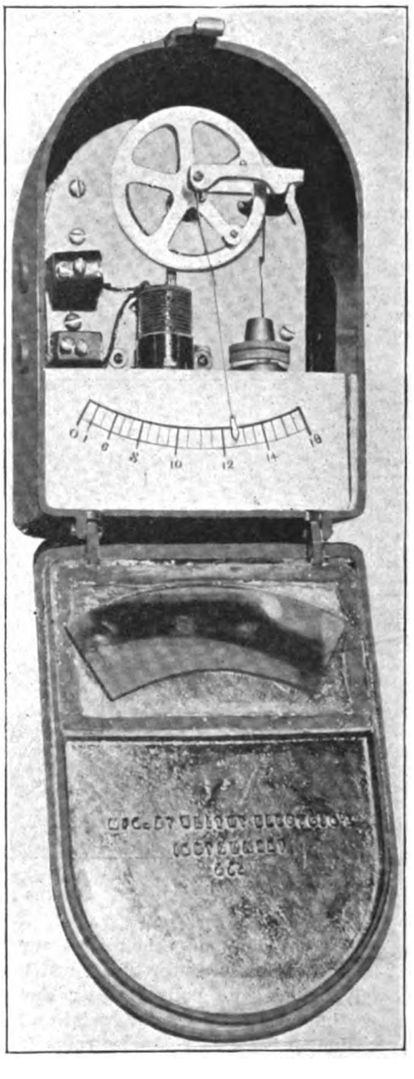


FIG. 3.—A MAXIMUM DEMAND METER.

is shown in Fig. 5, made by the Western Electric Company. The design of the lamp embodies several radical peculiarities. One of the most interesting of these is the regulating mechanism. All previous lamps, with one or two exceptions, employ an alternating current magnet or solenoid, which draws up an armature or plunger when the current through the lamp be-

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comes greater than normal and allows the armature or plunger to fall away when the current becomes less than normal. The inherent difficulty with such

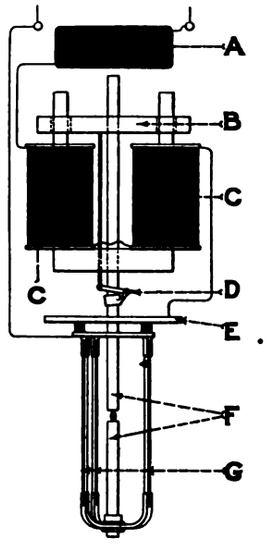



FIG. 4.—DIAGRAM OF PARTS OF PETITE ARC LAMP.

lamps, no matter what the shaping of the magnetic circuit may be, is the fact that the reluctance of the circuit becomes less when the armature is drawn in close to the cores or the plunger is drawn into the solenoid so that it requires a considerable fall of the current before the armature or plunger may be retracted, after which the reluctance is reduced and a considerable rise of the current must occur before they will be again drawn in.

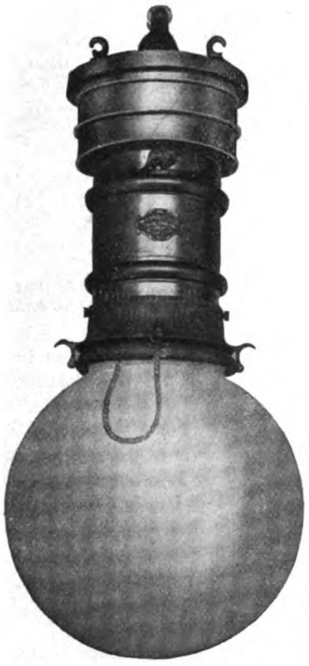


FIG. 5.—THE PETITE ARC LAMP.

The regulating mechanism of the Petite arc lamp is magnetic in character, but instead of the attraction of a magnet for an armature it utilizes the repulsion of an alternating current magnet for a short-circuited secondary. The principle of its operation is shown in Fig. 4, where B is an armature of aluminum, surrounding the upper ends of the cores of the magnet, C, and attached to the clutch shown, which grasps the upper carbon. The repulsion is obtained by means of the currents generated in the aluminum of the armature, which tend to force the latter upward, lifting the carbon with it. The upward motion allows the magnetism to leak away below the armature, keeping the armature in a stable suspension over a considerable range of motion with a small range of current.

Another detail of interest is the return circuit from the lower carbon. This is divided and passes up through the three side rods or supports, G, spaced at equal radial distances around the arc, so that the magnetic effect of the current on the arc is eliminated and the arc does not tend to burn out on one side of the carbons and flame, as it does in some lamps where the current passes up entirely at one side of the arc. The lamp is provided with a choking coil, A, with a ring-shaped magnetic circuit, the windings being tapped out with various terminals for different voltages and the two standard frequencies. The contact with the upper carbon is obtained by means of a clamp at its upper end connected through a flexible cord. An air dash pot is used to prevent too abrupt movements of the parts.

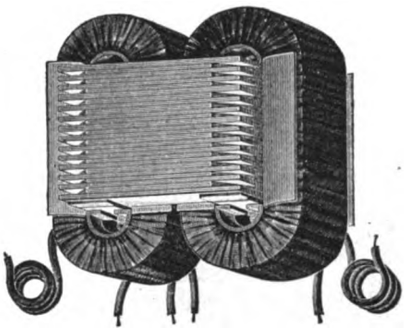


FIG. 6.—AN IMPROVEMENT IN TRANSFORMER CORE CONSTRUCTION.

The lamp is made in various styles, with inner and outer globes or with inner globes and reflecting shades, as well as in a marine type. A hood is provided for out-of-doors service.

### IMPROVEMENTS IN THE SCHEEFFER TRANSFORMERS.

Transformer construction has reached such an advanced stage that further advances are only in the refinement of details. An advance of this kind, simple in character, but for that reason all the more valuable, is embodied in the most recent types of transformers built by the Diamond Meter Company, Peoria, Illinois.

The appearance of the coils and core of this transformer is shown in Fig. 6, the improvement referred to being the arrangement of the corners of the stampings. In a rectangular magnetic circuit the lines of force make but little use of the outside corners of the laminae, rounding the inside corners by shorter paths. Some manufacturers cut the outside corners away and others leave them in place. In the Scheeffer transformer half of them are cut away and the laminae are assembled in bunches, with full and cut-away corners alternating, leaving slots across the corners, such as are clearly shown in the illustration. In this way the radiating surface of the core is considerably increased without the removal of any valuable iron, and hence without increasing the density at any point. The transformer bears other evidences of careful design, notably the semi-circular forms about which the coils are bent, preventing any cutting of the coils on sharp corners.

The improvement in the core structure described is the invention of Mr. G. A. Scheeffer, covered by patent No. 627,144, recently issued.

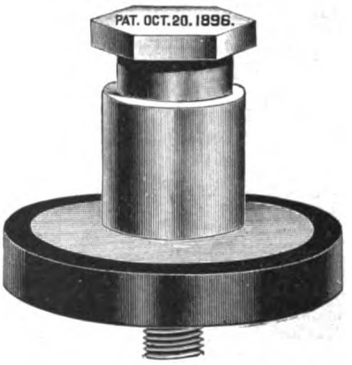



FIG. 7.—PERSPECTIVE VIEW OF PUMP VALVE.

### THE PARKER PUMP VALVE STEM.

An improved form of stem for pump valves is shown in perspective in Fig. 7 and in section in Fig. 8. The latter illustration shows clearly the features which characterize this stem and render it an improvement on older forms. The use of an upper guide, as well as a lower, insures a more accurate alignment and square seating of the valve and reduces the wear, which otherwise causes the hole in the valve to get out of shape or become enlarged. The spring is encased in its own chamber. Broken pieces of the spring cannot get through the pump to damage packing or other parts. After one side of the valve is worn it can be reversed, thus get-

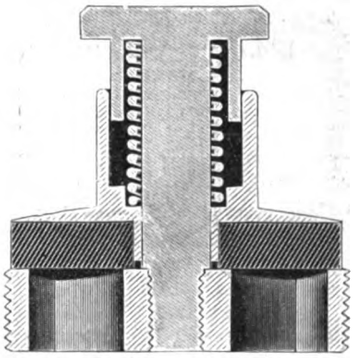


FIG. 8.—SECTION OF PUMP VALVE.

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ting double wear. It is claimed that the valves seat more promptly, reducing slippage and saving the steam.

This valve stem is manufactured by Jas. McCrea & Company, Chicago, Illinois, in connection with their older product, the Climax steam clamp joint. The pump stem has already come into quite wide use, over 3500 of them being used by the Standard Oil Company at one plant.

### METALLIC GASKETS FOR GENERAL PACKING PURPOSES.

In Figs. 9 and 10 are shown two forms of a metallic gasket, an improvement over the old leather and rubber article, for ren-

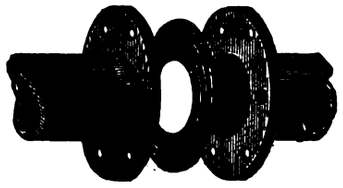


FIG. 9. METALLIC FLANGE JOINT GASKET.

dering steam-tight the flange connections of steam piping, as well as many other bolted joints subjected to fluid pressures. The illustrations show two different patterns of the metallic gasket, which consists of thin sheet copper stamped with concentric currugations. Three to six corrugations answer as well as more, the space available within the bolt holes determining the width of the gasket. Connections made by the use of this improved article are not affected by heat and pressure in such a way as to be blown out after continued use, for each corrugation makes the entire circle of the flange, and so long as the contact is kept complete by compression the joint cannot leak. This style of gasket is naturally not impaired by the repeated expansion and contraction of steam pipes, as its springy nature allows it to follow changes of its bounding surfaces. It is, therefore, of particular value on pipes in which steam is used intermittently. In cost these goods compare favorably with other gaskets now upon the market, and as they are furnished to steam users the exact size re-

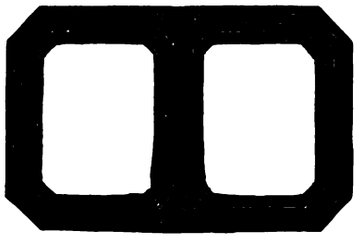


FIG. 10.—METALLIC GASKET FOR RECTANGULAR JOINT.

quired to make a tight joint, there is no surplus material to be paid for.

Aside from the circular and square patterns here illustrated, the manufacturers have also oval, rectangular and irregular shapes for steam chests and cylinders of engines and pumps. Their line embraces lip union, flange union, plain and ball joint gaskets for carrying water, steam, air and gas. Parties desiring to give the goods a trial on any leaking joints may have samples upon application to the U. S. Mineral Wool Company, 2 Cortlandt Street, New York City, or the Bourne & Knowles Manufacturing Company, Cleveland, O.

### AN INTERNAL SELF OILING AUTOMATIC STEAM ENGINE.

The distinctive feature of this new design of engine, put on the market by the Ball Engine Company, is the automatic oiling system.

It will be seen by the sectional view, Fig. 11, that the oil is contained in a pocket in the bottom of the frame. The crank discs in revolving carry over a portion of this oil into a trough in the top of the frame, covered in by the hood. Thence the oil flows in streams into the main bearings, and is also carried by the radial holes to the crank pin.

There are removable guiding plates, one on each side of the connecting rod at the ends of the guides next to the crank discs, so arranged that they make a slot through which the oil is guided directly into the crosshead, which has a large bell-shaped opening to receive it.

As the guiding plates guide the oil directly into the crosshead, the doors on the side of the frame may be taken away for the purpose of taking indicator cards or for examination of the crosshead, without the oil being thrown on the engineer or on the floor.

Another important feature in connection with the oiling device is the dividing wall between the cylinder-head and the crosshead chamber of the frame. By means of this the oil is kept cool and the water of condensation from the piston rod stuffing box is prevented from mixing with the oil in the frame, while access to the piston-rod stuffing box is gained by openings in the frame between the division wall and the cylinder head, as shown.

In the front or crank end of the engine will be seen a hand hole closed by a plate screwed in. By unscrewing the plate access may be gained to the crank-pin boxes for adjustment. This obviates the necessity of removing the hood.

The hood, which is made of cast-iron corrugated, is fitted absolutely oil tight and rests in a groove without fastenings of any kind, and therefore may be readily removed, exposing the discs and crank end of the connecting rod.

The connecting rod and straps are forged from steel blooms. The adjustments are by means of wedges operated by T-pointed set-screws, which move the wedges up or down. As the movement of the wedges is in the same direction, the length of the rod is not altered, nor is the position of the piston changed.

The crank-shaft is a single forging of open-hearth steel, containing the proper amount of carbon to give strength and durability, and ground to an accurate, smooth-running surface. Cast-iron discs are secured to the shaft by keys in such a manner as to prevent their getting loose or impairing the strength of the shaft.

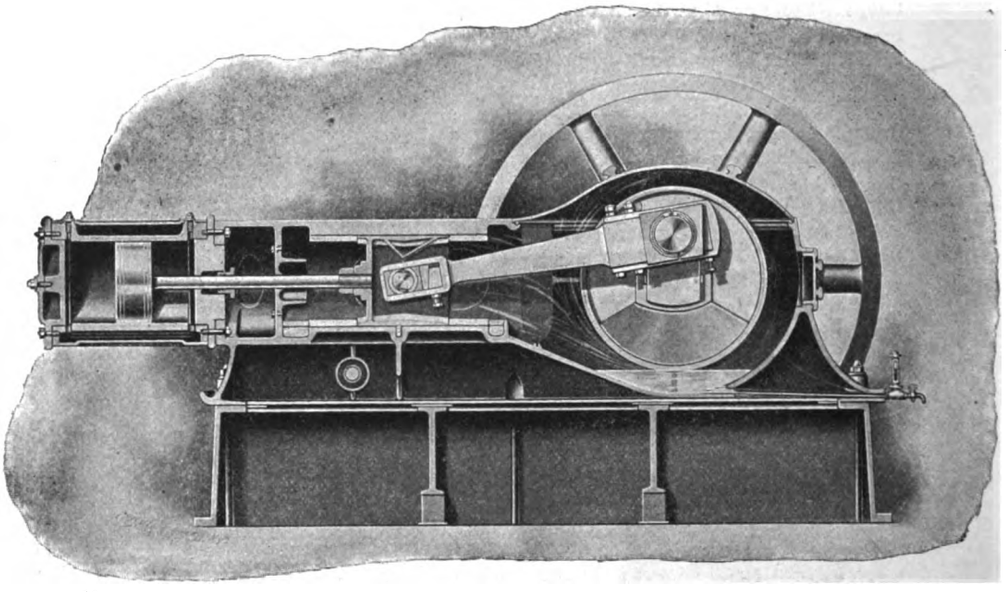


FIG. 11.—SECTION SHOWING CONSTRUCTION AND OILING ARRANGEMENTS OF BALL ENGINE.

The introduction of the shaft into the engine is accomplished by arranging the shaft boxes (which are entirely separate from the frame) in a jaw cutting into the bed deep enough to bring the center of the shaft in a plane with the center line of the engine, finished spots being provided to meet corresponding finished surfaces on the boxes.

A new and desirable feature is the self-oiling eccentric and strap. The straps are designed with a reservoir at the bottom containing oil, and by an arrangement of flanges and grooves the oil circulates around the eccentric while in motion, and only requires to be renewed at long intervals.

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THE LEFFEL "CLASS B" ENGINES.

The accompanying illustrations represent the class "B" standard center crank automatic cut-off engines being put on the market by James Leffel & Co., Springfield, Ohio. They are intended to meet

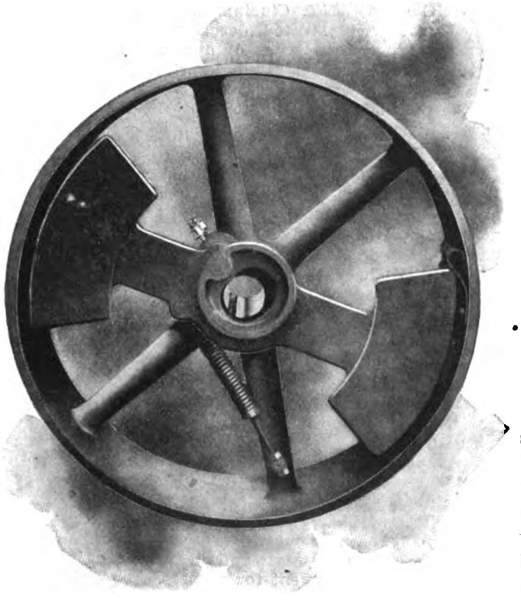


FIG. 12.—VIEW SHOWING GOVERNOR IN BAND FLY WHEEL.

the demand for a thoroughly good, simple and easily cared for line of automatic engines in the smaller sizes up to 50 h. p., that will prove durable and economical in operation. Fig. 13 is a view showing steam chest side, and Fig. 12 illustrates the governor in the band fly wheel.

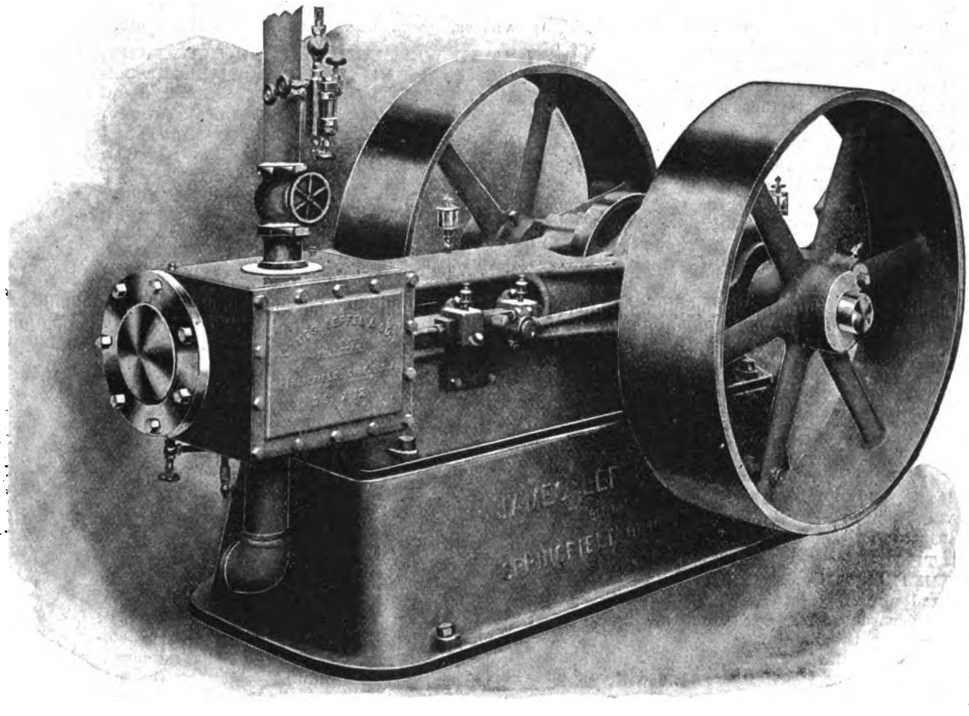


FIG. 13.—VIEW SHOWING STEAM CHEST SIDE OF ENGINE.

The main frame or bed is of substantial proportions, and of a design affording extra strength and stiffness. The cylinder and steam chest are of the overhanging type, cast together, and firmly bolted to bed. The cross-head guides are a part of bed, bored out, and have very generous surfaces. The cross-head is of improved mechanical design, having pin about mid-center, and provided with gun metal wedge-shaped shoes above and below, arranged for convenient adjustment. The manner of fitting cross-head pin enables it to be easily kept absolutely tight at all times. The piston rod is of steel, and turned to a tight force fit in the piston, with a suitable shoulder, against which the piston is forced on rod, the end of latter being then securely riveted over, tightly and firmly holding the piston in place.

The connecting rod is provided with extra heavy brass boxes at each end, easily adjustable for taking up wear and keeping distance between centers same at all times. The main shaft is extra large and strong, forged in one solid piece, from best quality hammered iron or steel, and is provided with suitable counter balance discs, securely attached. The rectangular form of skeleton slide valve is used, balanced by being fitted with a pressure-relieving plate on back between valve and steam chest lid, and is arranged to afford necessary relief in case of water in cylinder, and is also made adjustable for wear. This gives a simple, efficient and well balanced valve, that is easily understood, and no more trouble to care for than the ordinary type of plain slide valve. A simple and convenient device (not shown in cuts) is provided for draining the cylinder, same being operated by one lever, and having outlet from each cylinder cock suitably connected to exhaust pipe.

These engines are equipped with the Rite's governing system, which is the acme of simplicity, as shown in Fig. 12. The governor consists of one piece, comprising the arms and weights, with one spring connection, and is pivoted on one hardened steel pin—nothing complicated, no links, no numerous joints or complicated parts. This governor, with the balanced valve used, affords a regulation that is practically perfect, speed being constant, and the same with engine loaded or running empty.

## NEW BOOKS.

Diagrams and Handbook for Telegraph Engineers. By Willis H. Jones. New York: Pocket edition. The Telegraph Age; 115 pages. Price, $1.00.

This work consists of 47 sheets of diagrams, showing most plainly the connections of telegraph sets in the varied ways of modern practice. The diagrams are very clearly drawn, the different instruments being represented by pictorial figures which cannot be mistaken, and every part of the circuit is named, so that they are practically self-explanatory. These are supplemented by a number of useful tables, rules and other pieces of information.

The Indicator Handbook. By Chas. N. Pickworth. Part 1, the Indicator, Its Construction and Application. New York: D. Van Nostrand & Company. 126 pages, illustrated. Price, $1.50.

This work is a thorough, practical manual on the use and application of the indicator. Three chapters are devoted respectively to the construction of the indicator, of its attachments and of its reducing gear, and following each is a chapter devoted to the errors of the devices described, so that users may find complete data by which to obtain the most accurate results. The work is illustrated by carefully made drawings and wood cuts of ample size to show plainly the exact nature of the devices referred to. The author is editor of the "Mechanical World" and shows throughout the work complete familiarity with the subject discussed.

The Slide Rule. A Practical Manual by Chas. N. Pickworth. Fifth edition, revised and enlarged. New York: D. Van Nostrand & Company; 88 pages. Price, 80c.

The rewriting of this work, which has exhausted four editions in but little more than as many years, has allowed the introduction of considerable new matter, making it a thorough manual on slide-rule computation. Many constant users of the slide rule for simple work have no conception of the value such an instrument would have in their calculations were they capable of utilizing all its functions. The perusal of this manual, which is thoroughly practical in character, would prove of great value to them as well as to those who have not as yet taken up the use of the slide rule at all.

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## OBITUARY.

MR. HERBERT H. BROOKS, for the past ten years General Manager of the American Circular Loom Company, Boston, Mass., died suddenly Sunday, July 9th, from lung trouble culminating in consumption. Mr. Brooks was very widely known to the supply men throughout the United States.

## LEGAL NOTES.

THE GENERAL ELECTRIC COMPANY'S RAILWAY PATENTS.—During the months of June and July the General Electric Company has obtained preliminary injunctions under the Van Depoele patent for suspended switches No. 424,695 against the Worcester & Clinton Street Railway Company and the Central Union Brass Company of St. Louis, Mo. Under the Condict patent No. 393,323, on series parallel controllers the company has obtained preliminary injunctions against the Worcester & Clinton Street Railway Company and the Mill Creek Valley Street Railway Company.

THE LEE INJECTOR MANUFACTURING COMPANY is the name of the successor to the Lee-Penberthy Manufacturing Company, manufacturers of the well-known Lee injector and other steam specialties. The change of name signifies no change of policy or interference with the manufacture and sale of Lee injectors, but is simply a result of a suit instituted by the Penberthy Injector Company to restrain the former Lee-Penberthy Manufacturing Company from using the name Penberthy in its corporate title. Mr. William O. Lee, Secretary and Manager of the new company, announces that it will push the construction and sale of the Lee injectors in future as well as in the past, and that Thos. J. Sweeney will be associated with the new company as mechanical expert.

THE TRUSTEE'S SALE OF THE DIAMOND ELECTRIC COMPANY.—On July 20th the accounts and miscellaneous assets of the Diamond Electric Company, formerly of Peoria, Illinois, were sold in bankruptcy proceedings in Chicago. The company became involved last Fall, parties holding judgments against them closing the factory, which was then sold by the United States Marshal in October. The plant was afterwards bought by the Diamond Meter Company, which now operates it, manufacturing Scheeffer transformers and integrating meters. No one connected with the new company was interested in the old with the exception of Mr. G. A. Scheeffer, who was the superintendent of the old, as he is of the new works. The remaining assets of the old company, chiefly unsettled accounts, were placed in the hands of an assignee and sold, as noted above, on July 20th.

## PERSONALS.

MR. G. F. GREENWOOD, consulting engineer of the Consolidated Traction Company, Pittsburgh, Pa., has been selected to be engineer in charge of the work of rebuilding and reconstructing the street car lines in Havana, Cuba. Mr. Greenwood will not commence his new duties until early in the fall.

MR. MARK A. REPLOGLE, well known for his work in the development of water wheel governors, and heretofore associated with the Replogle Governor Works of Akron, Ohio, has connected himself with the Webster, Camp & Lane Machine Company of the same city, which company will make a specialty of equipping water powers with wheels designed and controlled for accurate governing.

MR. G. H. CONDIT, the electrical engineer of the Electric Vehicle Company, has, since the consolidation of this company with the automobile department of the Pope Manufacturing Company, become the consulting engineer of the consolidated interests and has consequently moved to Hartford, Conn. Mr. Condit is well recognized as one of the foremost electrical automobile designers in this country, the development of the electric cabs and broughams now running in considerable numbers in New York City being largely from his designs, as is also the remarkable charging equipment for the same.

MR. HENRY HINE, the general manager of the Stanley Electric Manufacturing Company, has been appointed general manager of the Sprague Electric Company, and assumed office on July 12. This completes the new list of Sprague officers, consisting of A. B. Chandler, president of the Postal Telegraph Company, president; John E. Searles, first vice-president; Frank J. Sprague, second vice-president and technical director; and Henry Hine, general manager. Mr. Hine has been general manager of the Stanley Company for the past eight years, prior to which time he was connected with the Westinghouse and Sawyer-Man Companies, and has always been prominent in the electric manufacturing business. For the present, he will continue in the management of the Stanley Company as well as assuming similar functions with the Sprague Company.

HENRY S. WEBB, until the end of the college year just closing connected with the department of electrical engineering of Lehigh University under the direction of Prof. Franklin, has resigned from this position and accepted that recently vacated by Mr. Kempster B. Miller in the International Correspondence Schools, Scranton, Pa. Mr. Webb is well known to readers of the American Electrician through his contributions, particularly on the subject of telephony. His work with the International Schools will be instruction and preparation of text books on telephony and telegraphy. Mr. Webb is a young man, having graduated from the electrical engineering course of the Massachusetts Institute of Technology only seven years ago. His first work after leaving college was with the General Electric Company, where he spent about a year, after which he engaged for a short time in contracting engineering work in Cincinnati, since which time he has been connected with Lehigh University as noted above, having charge of some of the electrical laboratories and particularly of the telegraph and telephone instruction. Mr. Webb's ability to not only comprehend and keep posted upon the advances of electrical engineering, but also to make them clear to others, has been evident from his contributions to the electrical press. The management of the International Correspondence School has, in obtaining him, shown another instance of its good judgment in the selection of members of its staff of instructors.

## TRADE PUBLICATIONS.

THE C & C ELECTRIC COMPANY, New York City, has issued a new bulletin, No. 129, of its motors and controllers, succeeding several previous publications.

THE FAIRBANKS COMPANY, New York City, has issued a complete illustrated catalogue and price list of its asbestor disc valves, asbestos cocks, vulcabeston packing, injectors, traps, hydrants, service boxes, etc.

THE S. S. WHITE DENTAL MANUFACTURING COMPANY, New York City, has issued a pamphlet on the general subject of painless dentistry by means of cataphoresis, outlining the medical value of this application of the electric current and describing the apparatus therefor.

THE JOSEPH DIXON CRUCIBLE COMPANY, Jersey City, N. J., has published a 40 page pamphlet on "Brazing by Immersion." The Dixon company makes crucibles especially designed for this process, as well as anti-flux brazing graphite which prevents the brass or spelter from sticking to the metal.

THE AMERICAN STEEL & WIRE COMPANY, the merger company which has absorbed the wire making industries of this country, had representatives at the Independent Telephone Association convention at Chicago, who distributed the thirteenth annual edition of the pocket hand-book on iron and copper wire, as published by the Washburn & Moen Manufacturing Company.

THE BULLOCK ELECTRIC MANUFACTURING COMPANY, Cincinnati, Ohio, has issued a new illustrated descriptive catalogue of its various types of dynamos and motors, including illustrated descriptions of the Bullock system for operating web presses, the controlling panels made by the company for press driving motors and the company's new magnetic blow-out controller.

THE B. F. STURTEVANT COMPANY, Boston, Mass., is distributing a novelty in advertising literature entitled "2500 Witnesses," which consists of a 48-page list of users of Sturtevant ventilating and heating apparatus. The list is classified so that any one who contemplates the purchase of such apparatus may immediately find a list of others in his own line of business who are using Sturtevant equipments.

THE CROCKER-WHEELER ELECTRIC COMPANY, Ampere, N. J., has taken up in its Publication Bureau the different industries in which Crocker-Wheeler machines may be used, and is publishing special pamphlets for each; one entitled "Electricity for Printers" has recently been sent out to publishing establishments, pointing out the ease of control, efficiency, increased output, flexibility, decreased waste and cleanliness of motor driving equipment for presses.

THE MASON REGULATOR COMPANY, Boston, Mass., has published a convenient catalogue of some 40 pages of the steam specialties for which it has become famous. The exact nature of each device is thoroughly made clear by cross sections of the instrument with accompanying explanations. Central station engineers will therefore find the catalogue—even if they have no immediate need for any apparatus described therein—an interesting and instructive work on valves, governors, damper regulators, etc.

THE WESTERN ELECTRIC COMPANY, Chicago and New York, has published a bulletin, No. 9001, describing the Facil hand register and other accessories of the system of police and fire alarm invented by and named after City Electrician Ellicott of Chicago. The bulletin illustrates and describes a battery of 8 machines used as motor generators in the City Hall, Chicago, put in originally to carry the police and fire alarm lines while the storage battery was being charged. The machines were started up over 4 months ago and it has not been found necessary as yet to put the storage battery again in circuit.

THE ELECTRIC STORAGE BATTERY COMPANY, Philadelphia, Pa., has described in a bulletin the equipment of chloride accumulators in the Dun Building. The chief peculiarity of this equipment is the location of the battery, which is in a light fireproof structure on the roof, giving it ample room and light and ideal ventilation with no danger of fumes in the building. The battery has a capacity of 720 ampere hours at a one-hour discharge rate, and serves the triple purpose of smoothing the load curve on the generators, steadying the voltage and providing an emergency or night source of current for the lighting and electric elevators. Owing to the fact that the generators are run at constant load, the fluctuations being taken by the battery, the coal consumption has been found to be reduced 25 per cent. below that with the battery out of service. The building is owned by the well-known house of R. G. Dun & Company, for whom nothing is too good, and the electrical equipment consists throughout of the finest available apparatus.

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THE WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY has issued two new bulletins, one on its type "C" polyphase induction motors for constant speed and the other on its central station transformers and transformer fuse blocks. The former illustrates the latest types of induction motors up to and including the 500 h. p. size, which is the largest of this type built by this company. The other bulletin describes the well-known Westinghouse transformer with the peculiar open ventilated housing designed for interior work, which allows the atmosphere an open circulation around the windings and core of the transformer.

THE PEERLESS RUBBER MANUFACTURING COMPANY, New York City, has distributed a highly colored poster representing pictorially a brownie scene, entitled "The Brainies hold an engineering contest." A comparison of the two pictures shown, one showing the trouble given by an engine on which is used "just as good packing," and the other the running of an engine packed with Rainbow packing, emphasizes the conclusion that the latter is the life of the driving power of machinery. The company offers a reward of $25 for evidence of the substitution of other packing on orders for Rainbow, with the improper use of the name or its abbreviation, Rbw.

THE WARD-LEONARD ELECTRIC COMPANY, Bronxville, N. Y., has published a catalogue, No. 996, listing enamel field rheostats of the Carpenter type. These are designed with what is called a "2 to 1 taper in ampere capacity," this expression meaning that the ampere capacity of the different steps of the rheostats is tapered so that the carrying capacity at the maximum current end is twice that at the minimum current or maximum resistance end, in addition to which the resistance of the different steps is varied inversely as the square of the amperes. The catalogue advises users that good results will be obtained by using rheostats the resistance of which is about equal to that of the field to be regulated.

A SYSTEM OF ENGINES is the title of one of the most interesting and complete catalogues of any engine building house ever published. It describes the various engines built by the Harris Foundry & Machine Works, Harrisburg, Pa. As engine users have already learned, these works do not attempt to specify one type of engine for the many different uses where steam power is needed, but make engines of four general types, each of which is made in several different styles, simple, tandem or cross-compound, etc., and of a large range of sizes. This makes a total of 22 styles of engines, ranging in size from 6 to 300 h. p. capacity. The 4 general types are the Ideal, the Harrisburg Standard Single Valve, the Harrisburg Standard Four Valve and the Harrisburg Corliss. The catalogue has been published in two editions, one on coated paper to show the handsome half-tone illustrations and with the ordinary paper cover, and the other an edition de luxe printed on rough hand-made paper with deckel edge and with a library binding of half morocco. The illustrations in this edition are on artists' proof sheets, separately bound in. As a work of fine book making it is propably unsurpassed in trade literature. The company announces that it has been running day and night for the past ten months and has refused, owing to the crowded condition of its establishment, many otherwise attractive contracts. It is at present having work done in its four separate establishments to keep up with the contracts on hand, while its present output is three times greater than that of 1897.

WIRT RHEOSTATS AND THEATRE DIMMERS are described in a bulletin issued by Chas. Wirt & Company, Philadelphia, Pa., consisting of advance sheets of a new catalogue to be published. Among the good points brought out about these rheostats are the facts that they are completely encased in cast iron, affording ample protection and a good radiating material; there are a large number of steps, no rheostats having less than fifty; the commutator is protected against injury by being placed below the surface level and is made of phosphor bronze; there are no small parts, such as pins, nuts, etc.; the insulation used is mica, capable of withstanding sudden changes of temperature and consequent changes of volume without cracking; and the resistance is a continuous metallic ribbon, containing no contacts liable to break joint. The rheostats are rated in two different ways, one for loads to give a rise of temperature not over 100° F. above surroundings and the other not over 200° F. The first has one watt per sq. in. and the second three watts per sq. in. of cooling area. The theatre dimmers are made in a large number of styles to suit different demands, one convenient form for a main dimmer being made with a vertical shaft, to which plates may be added in any number below the floor, the hand wheel being above. They are also made with pairs of plates for the three-wire system and in the larger sizes with interlocking switches, enabling two or more banks of lights to be controlled together. A dimmer is often called upon to work with much less than its full load. In this case most of the dimming will be done upon the last few steps of resistance cut in, and unless the dimmer has a large number of steps the jumps on these last few contacts will be perceptible. For this reason no Wirt dimmer has less than 50 steps, no matter how small its size.

## BUSINESS NEWS.

THE CENTRAL ELECTRIC COMPANY, CHICAGO, as selling agent, reports that it is gaining many orders for Columbia lamps.

THE OREGON TELEPHONE AND TELEGRAPH COMPANY has recently laid a six-conductor cable, 4725 ft. long, under the Columbia River at Vancouver, Washington.

THE AUSTIN STEAM AND OIL SEPARATOR is reported by the manufacturers, the Austin Separator Company, Detroit, Mich., to be meeting a large foreign demand.

THE KENNEDY VALVE MANUFACTURING COMPANY, at Coxsackie, N. Y., is planning improvements and additions to its plant. The additions are a two-story building, 45 x 120 feet, for offices and machine shops, also a foundry addition of 25 x 75 feet, and the installation of a new 125 h. p. engine.

TROTTER'S MONA COMMUTATOR COMPOUND, as made by Trotter's Mona Manufacturing Company, is a most efficient lubricator for either carbon or copper brushes. A sample will be sent free to any one who wishes to give it a trial and will send his address to Messrs. Goldmark & Wallace, New York City.

MESSRS. SEMPLE BROTHERS, Pittsburgh, Pa., will hereafter manufacture black varnishes by the processes heretofore used by the Sterling Varnish Company of the same city. The latter company will temporarily cease the manufacture of these products owing to press of business in other directions, and its trade in these lines will be turned over to the new makers.

EUREKA PACKING was, during the recent war, carried in the storeroom of every vessel in the United States Navy, according to the statement of the makers, Jas. L. Robertson & Sons, New York City. The demand for it has grown to such an extent that imitations have been put on the market, and users are requested to look for the red diamond-shaped label on every box and also on every two feet of packing.

THE RUMSEY ELECTRICAL MANUFACTURING COMPANY, Philadelphia, Pa., has been appointed Eastern sales agent for the Pittsburgh Transformer Company, its territory including Eastern Pennsylvania, Southern New Jersey, Delaware, Maryland, West Virginia and Virginia. This company is well known and popular among the trade, deservedly so on account of its careful and conscientious business methods.

MESSRS. SHEEHAN & HEWITT, Newburgh, N. Y., electrical engineers, contractors and builders of switchboard and other appartus, have dissolved partnership, Mr. W. M. Sheehan retiring from the firm. Mr. Chas. E. Hewitt has formed a co-partnership with Mr. H. A. Warden, the firm to be known as Hewitt & Warden and to carry on the business previously conducted by Sheehan & Hewitt.

THE STANDARD UNDERGROUND CABLE COMPANY, Pittsburgh, Pa., intends to benefit from the contemporaneous policy of expansion of the United States Government by taking up the manufacture of deep sea cables. The company hopes to secure the contract for the cable which is to connect the Hawaiian Islands with San Francisco. The firm's representatives have examined several sites on the eastern seaboard for the location of a station where the cable can be loaded aboard ship.

THE BULLOCK ELECTRIC MANUFACTURING COMPANY, Cincinnati, Ohio, announces that the combination of prosperous times with the record the company has established for high-grade electrical machinery has developed such a demand for its apparatus that its new factory—with three times the capacity of the former works—is overtaxed to meet the demand created by its sales department. The difficulty will soon be remedied by a further increase of manufacturing facilities.

THE AMERICAN ELECTRIC TELEPHONE COMPANY has moved into a new building, 38-50 Jackson Boulevard, corner Canal Street, Chicago, Ill. The change in quarters was made necessary by the company's rapidly increasing business, which it reports has quadrupled during the last year. The new building is a modern eight-story structure, which has been equipped with the latest automatic machinery, making it one of the largest and finest telephone manufacturing establishments in the world.

THE H. C. ROBERTS ELECTRICAL SUPPLY COMPANY, Philadelphia, reports a steady increase in the demand for its products, among the recent sales of trolley and feeder wire being large quantities to the interurban electric railway from Dayton to Xenia, O.; the Schuylkill Valley Electric Railway Company, of Pottsville, Pa., and the Norfolk Terminal Company, Norfolk, Va. The company's wire has also been shipped to Lewiston, Pa.; Cincinnati, O.; Rising Sun, Ind., and numerous other places.

MR. H. R. WELLMAN, who has been the electrical engineer of the Armitage-Herschell Company, N. Tonawanda, New York, for some three years, resigned on July 10th to accept a similar position with the General Incandescent Arc Light Company of New York City. Mr. Wellman has done no small amount of difficult and original work with the Armitage-Herschell Company, notably in the design of dynamos and motors, and particularly of motors and controlling apparatus for electric elevator service, one of the most difficult fields of design, his success in which evidences his ability in the laying out of electrical machinery.

THE HOPPES MANUFACTURING COMPANY, Springfield, Ohio, has received the following repeat orders, in addition to those mentioned in the last issue of the American Electrician, which furnish additional evidence, if any were needed, of the satisfaction which its apparatus has given: The Kelly Axe Manufacturing Co., Alexandria, Ind., 400 h. p. live steam feed water purifier, and 400 h. p. exhaust steam feed water heater: The E. L. McClain Manufacturing Co., Greenfield, Ohio., 400 h. p. purifier, and 350 h. p.

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heater; The South Dakota Hospietal, Yankton, S. D., 200 h. p. purifier, and 400 h. p. exhaust steam feed water heater.

THE RENEWAL OF ACTIVITY AT THE FORT WAYNE WORKS.—Since the sale of the property of the Fort Wayne Electric Corporation to the General Electric Company the works at Fort Wayne, Indiana, have renewed their former air of bustle and activity. They are now running full time with a large addition to the number of men employed. The department devoted to the construction of Duncan meters has been active throughout the corporation's troubles and is now turning out meters at the rate of 600 per week. A new laboratory has been equipped for testing these meters. The works are in charge of Mr. J. J. Wood, of arc light fame, Mr. F. S. Hunting being the new Sales Manager.

PROSPECTS OF THE SIEMENS & HALSKE ELECTRIC COMPANY OF AMERICA.—The announcement that this company had been purchased by the Electric Vehicle Company has been the occasion of the idea that the Siemens & Halske Company would give up the manufacture of the lines of machinery which it has been building hitherto and devote its entire equipment to automobile work. Mr. C. S. Knight, Vice-President of the Siemens & Halske Company announces that this is not the case and that the only effect of the change of ownership will be the extension of the previous lines into new fields, notably the construction of arc and alternating as well as direct current and multiphase apparatus.

MR. JOHN S. NOWOTNY, Cincinnati, O., announces that he severed his connection with the Nowotny Electric Company March 31, 1898. Mr. Nowotny founded the Nowotny Electric Company and managed the business from its start until March 31, 1898. The assignment of the company, which occurred June 30, 1899, in no way affects him. After severing his connection with the above-named company, he immediately embarked in the manufacture of Nowotny's semi-vacuum long burning arc lamps and electrical specialties. The latter named business is owned solely by him and operated under his personal supervision and name, and is in no wise connected with the Nowotny Electric Company, which has made an assignment as noted above.

THE CLING-SURFACE MANUFACTURING COMPANY, Buffalo, N. Y., reports rapidly increasing sales, not only in this country but from Australia, Europe and South America. These, with a fast growing business in Mexico, go to prove that the truth of the oft-repeated phrase, "The days of tight belts are over," is appreciated by belt users. A recent letter from the engineer of Brown, Durrell & Company, Boston, voices the general verdict: "Having tried Cling-Surface on my 12 in. dynamo belt, I have been able to carry full load with 22 in. sag on the belt with no perceptible slip. It surpasses my expectations, and I can cheerfully recommend it to do all that is claimed for it if directions are followed."

THE RIKER ELECTRIC VEHICLE COMPANY has been incorporated under the laws of New Jersey, with a capital of $2,000,000, six per cent. non-cumulative preferred and $5,000,000 common stock. The company will purchase for cash all patents, machinery, contracts and rights of Andrew L. Riker and the Riker Electric Motor Company for the manufacture of electric vehicles. It will purchase extensive works at Elizabethport, N. J., which have a present capacity of five complete vehicles per day. Among those interested in the company are Andrew L. Riker, Charles A. Lieb, President of the Great Falls Power Company, of Washington; O. T. Crosby, of the Washington street railways, and F. C. Stevens, President of the West End Bank, Washington.

THE JOHN A. ROEBLING'S SONS COMPANY, of New York, was incorporated at Albany, N. Y., on May 25, with a capital of $100,000, to manufacture and deal in wire, wire rope, iron, steel, copper and all other metals and other materials used in connection with them, and to contract for building structures of such material and metals. The directors are: Washington A. Roebling, Charles G. Roebling, Jr., Frank O. Briggs, Charles G. Roebling and Ferdinand W. Roebling, of Trenton, N. J., and Henry L. Shippy and Edmund Roebling, of New York City. The company is controlled by the same people as the original New Jersey corporation, the company having been incorporated in New York State for convenience in doing business.

MR. F. C. SUTTER of the Pittsburgh Transformer Company, Pittsburgh, Pa., visited New York July 10th to 12th, his special mission being to obtain an agency for his company's apparatus in New York and New England. Mr. Sutter was fortunate in obtaining the Western Electric Company, who will hereafter handle the Pittsburgh "type K" transformer in these districts. Mr. Sutter stated that the Pittsburgh Transformer Company has found no summer season this year in its business, its orders increasing regularly month after month. The company has been obliged to put in new machinery as fast as possible to handle the growing trade. One large source of business is the active work of the Rumsey Electrical Manufacturers' Company, which is making exceptionally large sales in Philadelphia and adjoining territory, considering the fact that it is the summer season.

MR. E. V. BAILLARD, engaged in the business of machine construction and model making, has recently added extensively to his quarters at 106 Liberty Street, New York City, the extension practically tripling the former floor space. The new space is required for the addition of machine tools and other apparatus required by Mr. Baillard's growing business, which will be supplemented by more complete electrical testing instruments, rheostats, motors and other apparatus of value in experimental and model designing work. This is the second enlargement of Mr. Baillard's facilities during the last few years, the growth of his business being the natural outcome of the remarkable value of his services to inventors, machine designers and patentees, due to his wide experience in machine designing and unusual ability in assisting patrons in the solution of the many electrical and mechanical problems that arise in their work.

MURPHY AUTOMATIC SMOKELESS FURNACES were placed under the boilers of the Central High School building, Detroit, Michigan, about two years ago, displacing ordinary hand-fired furnaces. The economy realized has been so marked and the service so satisfactory in general that the Board of Education has closed a contract with Murphy Iron Works, Detroit, Michigan, to equip the boilers of all the school buildings of the city. Other recent sales are two additional furnaces for the Youngstown (Ohio) Electric Light Company, the Buffalo Cold Storage Company's plant, Buffalo, N. Y., the Home Telephone Building, and the Rose Building, Cleveland, Ohio., and the Union Iron & Steel Company's plant, Youngstown, Ohio. Four additional have been ordered by the United Traction Company, Pittsburgh, Pa., and two additional by the Western Reserve Building, Cleveland, Ohio, as well as two by Stanley R. McCormick's Building, Chicago.

MESSRS. MORRIS E. LEEDS & CO. have purchased the plant, drawings, fixtures, etc., of Elmer G. Willyoung & Co., and will continue the business at the old address, 939 Boyer St., Phila. Mr. Leeds is personally well equipped to conduct the business of manunfacturing scientific apparatus, as he has engaged in this line for the last ten years. His experience in this line has been general while filling the position of manager of the electrical and physical department of Queen & Co., Inc., which he resigned in May of the present year to engage in the enterprise already mentioned. The knowledge gained in his extended acquaintance with foreign manufacturers and methods, supplemented by five years of careful study of the requirements of the scientific public of America, has been of great value, and will be put to good use in developing the business of Morris E. Leeds & Co. Mr. James G. Biddle, 1038 Drexel Building, Phila., who acted as sole agent for Willyoung & Co., will act in the same capacity for Leeds & Co., so that as regards the selling end of the business there is no change whatever.


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THE HARRISON SAFETY BOILER Works announces a large list of recent sales of Cochrane Heaters and Cochrane Separators, among which are the following to electric light, street railway and electrical manufacturing companies: Cochrane heaters—Edison Electric Illuminating Company, Boston, Mass., 4000 h.p.; Worcester Electric Light Company, Worcester, Mass., 1500 h.p.; Saratoga (N. Y.) Traction Company, 150 h.p.; Rockland, Thomaston & Camden Street Railway Company, Rockland, Mo., 250 h.p.; Commonwealth Electric Company, Chicago, Ill., 3000 h.p.; Fort Worth (Tex.) Light & Power Company, 850 h.p.; Spartansburg (S. C.) Electric Light & Power Company, 600 h.p.; Cochrane separators—Missouri Railroad Company, St. Louis, Mo., 36-in. vacuum oil and two 12-in.; Saratoga (N. Y.) Traction Company, 10-in.; Missouri Edison Electric Company, St. Louis, Mo., three 10-in. receiver and one 10-in. horizontal; Spartansburg (S. C.) Electric Light & Power Company, three 6-in.; British Columbia Electric Railway Company, Ltd., Vancouver, B. C., two 8-in.; Electric Storage Battery Company, Philadelphia, Pa., 8-in.

MR. ELMER G. WILLYOUNG announces that he has discontinued the instrument business lately carried on by him in Philadelphia, Pa., under the designation of Elmer G. Willyoung & Co., and sold the plant in lump. He has made a close alliance with Messrs. Foote, Pierson & Co., of New York City, for a term of years. By the terms of this compact they will make, under his personal supervision, a full line of high class scientific and technical instruments and apparatus. To this end they have just added additional floor space, amounting to about 5000 square feet, to their already extensive plant, at 82-84 Fulton Street, which space is being equipped with the most modern and improved tools and appliances. Messrs. Foote, Pierson & Co, are the successors of the manufacturing department of E. S. Greeley & Co and are hence known to the electrical fraternity as makers of telegraph instruments and special mechanical devices. The contract constituting Mr. Jas. G. Biddle of Philadeplia, Pa., sole selling agent of Willyoung apparatus has been annulled, and henceforth Willyoung apparatus can be obtained only from Messrs. Foote, Pierson & Co. or the trade generally.

THE WESTINGHOUSE ELECTRIC AND MANUFACTURING COMPANY has recently equipped with electrical apparatus the building of the University Club, 5th Avenue and 53d Street, New York. The specifications were drawn up by Mr. C. O. Mailloux. The equipment includes one 75 kw., one 50 kw. and one 25 kw., 125 volt "engine type" Westinghouse generators, each direct connected to its own engine. The club will be handsomely illuminated with clusters of electric lamps. Another interesting installment recently completed by the same company is at Baron de Hersch's trade school on 64th Street, between 2d and 3d Avenues, New York City. The equipment includes one 50 kw. and one 25 kw. Westinghouse generator, 125 volts. The entire outfit at the trade school is a typical one, great care having been taken in arranging every part, as the school classes are taught the working of electrical apparatus by studying the operation of the machinery on their own premises. The Westinghouse Company has also contracted with the Burns estate to supply an electrical outfit for the new hotel now building at 5th Avenue and 45th Street, New York City. The installation will comprise one 150 kw. and one 100 kw., 230 volts, Westinghouse multipolar generators, direct connected to steam engines, running at 250 r. p. m.

THE PITTSBURGH BOILER SCALE COMPANY, Pittsburgh, Pa., offers a solution of the boiler scale problem quite different from most others in commercial use. Instead of treating the water by means of chemicals, which are likely to prove injurious to engine valves and packings, and instead of allowing the scale to form and afterwards removing it mechanically, the vaporizing surfaces of the boiler may be coated with a thin film of Pittsburgh boiler scale resolvent, which film will have the peculiar property of preventing the scale from attaching itself to the iron. The introduction of a little of the resolvent with the feed water will serve to coat with a greasy film each individual particle of the material as it solidifies, which will prevent these particles from forming into a hard, scaly mass and help hold them in suspension in the water, so that they may be readily removed by blowing down or washing out the boiler. The compound is a petroleum product, freed from any tarry ingredients that would injure boiler or engine surfaces and having a vaporizing point far above the temperature of the boiler, which insures it from passing off with the steam. It can be applied by means of a brush or swab to the shell, flues or tubes of the boiler when the latter is cold and dry, but may also be introduced into boilers with considerable scale on the surfaces. Its effect in the latter case is to gradually disintegrate the scale already formed, and in time reach the surface of the iron and form a film thereon.

THE UNION BOILER TUBE CLEANER COMPANY, of Pittsburgh, Pa., was organized in 1895 for the purpose of introducing an


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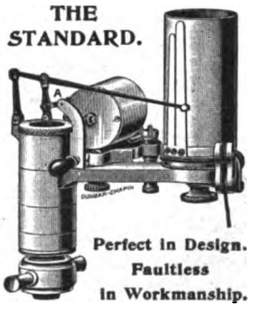
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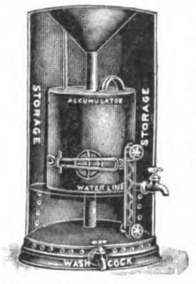

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entirely new industry, that of removing scale from the interiors of the tubes of water tube boilers. It has machinery especially designed for this specific business, by which it is enabled to safely contract for thoroughly cleaning boilers under a time limit with bond for heavy penalty for non-fulfilment, or to sell or lease tools for cleaning all makes of water tube boilers having straight, horizontal, inclined or vertical tubes, as well as those having curved tubes such as the Climax, Stirling, or even the Hazleton, having closed end tubes. The latter three types have heretofore been considered, and without this company's devices are yet, impossible to clean. The company commenced business as a firm May 1st, 1895, a time of the greatest industrial depression in the history of the country, notwithstanding which the great merits of the devices caused their immediate adoption by the largest concerns in the United States and England. Their value as a fuel saving device, as well as one that increases the efficiency of boilers even when practically new, was such as to call forth the highest praise from users. Such is the continued demand that notwithstanding the company started with a well equipped factory it is constantly enlarging the works, putting in additional machinery, and has more than doubled the force of workmen since the first of the year in its endeavors to keep up with orders. It has a flexible shaft which is unique in its way; having been compelled to design one to clean boilers having curved or other tubes inaccessible for a stiff rod, owing to the fact that other shafts would not stand the wear and tear under great stress.

THE INTERNATIONAL CORRESPONDENCE SCHOOLS, Scranton, Pa., have experienced during the last few years a phenomenal growth which shows the enormous demand for the kind of work they do as well as the satisfactory way in which they are doing it. The work of the schools has reached a magnitude which few unacquainted with them would ever imagine. The entire staff connected with the instruction and business department of the school numbers about 1,000 employees, of which 120 constitute the corps of instructors and assistants in the 57 distinct courses of study given. The number of students enrolled reaches the enormous aggregate of some 90,000. The equipment of the schools for handling this work is necessarily quite elaborate. The headquarters of the schools are located in two large buildings recently erected at a cost of $250,000. One of these, five stories in height is occupied by the business offices and instruction departments, and the other, a four-story building, is devoted exclusively to the printing and book-making departments. The amount of work carried on by correspondence is indicated by the fact that the postage expenses of the schools average in the neighborhood of $125 per day. In addition to the home office are more than a dozen branches maintained in the principal cities throughout the country, each under the charge of a superintendent. The territory of each of these branches is further divided into districts, each being in charge of an assistant superintendent. The business dealings of the school with its students are carried on by a number of solicitor collectors, under the charge of these assistant superintendents. The instruction and preparation of text books is carried on at the home office with the exception of a recent departure in the railway courses for which a car has been built which travels about the country giving students an opportunity to obtain a personal explanation of difficult points. This car has proven so satisfactory that two others are being built for the same purpose. The schools are controlled by the Colliery Engineer Company, incorporated with a capital of $1,250,000. The founder and General Manager is Mr. T. J. Foster, who established the schools in 1891.

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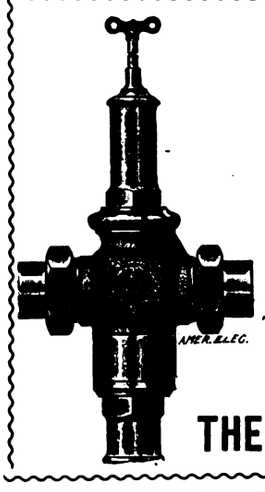
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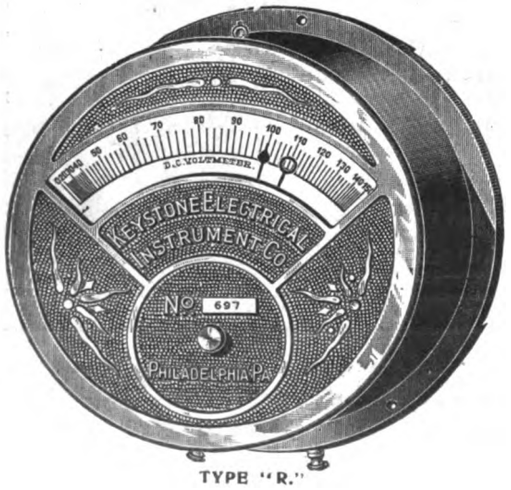
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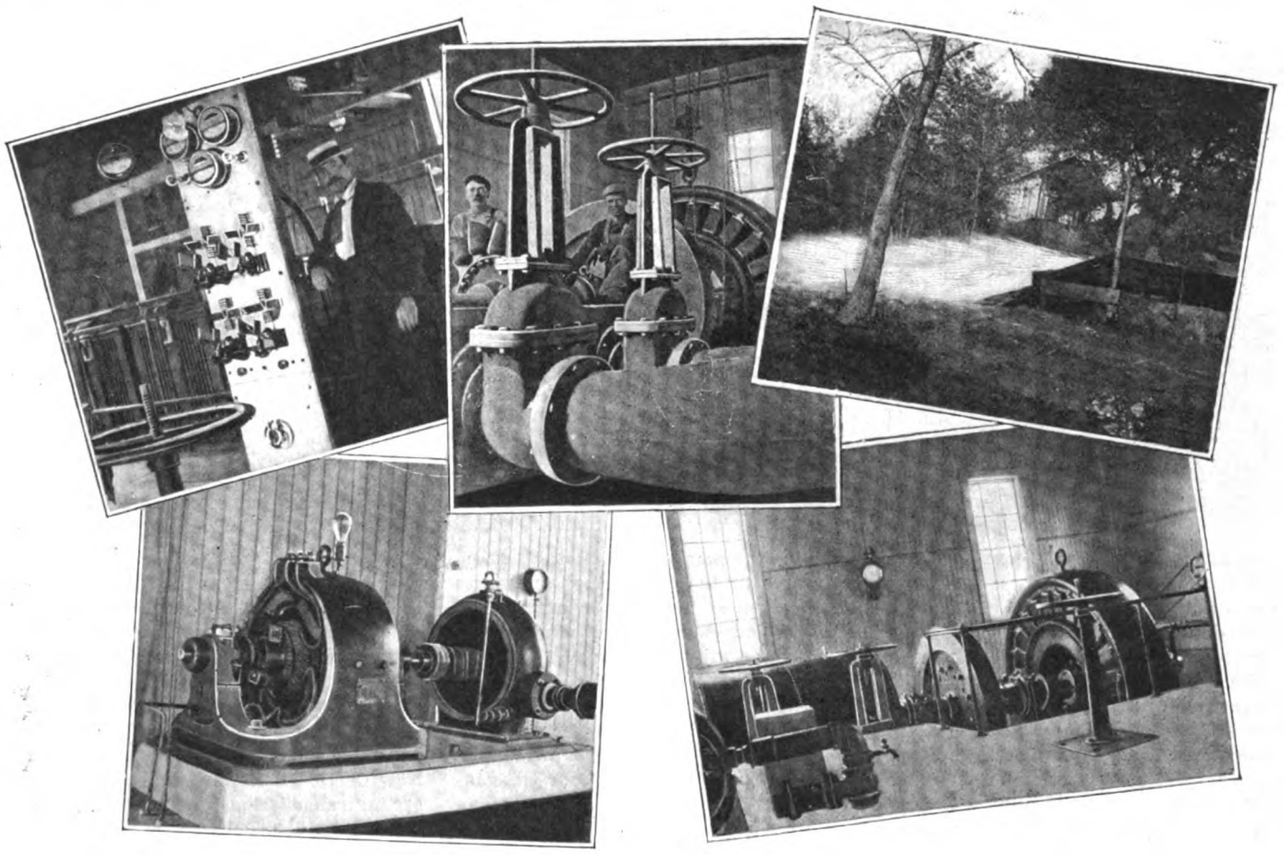
Vol. XI. New York, September, 1899. No. 9.

## THE AUBURN STATION OF THE CENTRAL CALIFORNIA ELECTRIC COMPANY.

**An Auxiliary Hydraulic Station Running in Parallel With Another Five Miles Away.**

The Central California Electric Company has recently erected an electric power house at Auburn, Placer County, California, to supplement the power already developed at New Castle and transmitted to Sacramento. The South Yuba Water Company provides irrigation for a vast tract of rich country on the Sierra Nevada Divide, northeast of Sacramento. At points upon the main canal, the water passes through rapids and over falls. One of such changes in level has been utilized by the Central California Electric Company, who two years ago erected a plant at New Castle to generate electricity. A reservoir was constructed and the water piped a distance of 6400 feet to the power house, where it is used to drive Pelton water wheels, which are direct connected to the 400-kw. Westinghouse two-phase generators. The power is generated at 500 volts two-phase, and passed through four 150 k.w. step-up transformers, which change it to three-phase at 15,000 volts, in which form it is transmitted to Sacramento, a distance of 29 miles.

The successful operation of this long distance transmission plant has led to the recent addition at Auburn, five miles beyond New Castle. About one mile north of the city of Auburn, the main, or Bear River, canal of the Yuba Water Company has a fall of about 200 feet within a distance of half a mile. Previous to the summer of 1898 the water flowed down Auburn Ravine, but has since been diverted to the canal. At this point of junction the new power house has been erected. A reservoir, capable of holding a day's supply, was built at the head of the ravine. The pipe connecting the reservoir and the power house is of riveted sheet steel varying in thickness from No. 12 to No. 6 at the receiver end. It is altogether 3100 ft. in length, the first 20 ft. being 54 ins. in diameter, which narrows to 200 ft. of 40-in. and finally to 36-in., which size is



THE SWITCHBOARD. THE GATES OF THE WATER WHEELS. THE OVERFLOW.
THE EXCITER. THE WHEELS AND GENERATOR.

VIEWS AT THE AUBURN POWER HOUSE OF THE CENTRAL CALIFORNIA ELECTRIC COMPANY.

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maintained throughout the remainder of its length. With the exception of about 200 ft. the pipe is buried at least one foot under the surface.

The power house is a frame structure 30 by 40 ft., covered with corrugated iron, the interior having a wainscoting of redwood up to the eaves. A composite traveling crane of ten tons capacity runs the length of the building. The main generating set is at the lower end, and is on a solid rock foundation. The water wheels being of small diameter, owing to the low load, the floor around their framework is higher than the generator floor, by this means the least possible head is lost in the discharge. The water wheels consist of two double nozzle solid disc 43-in. Pelton impulse wheels enclosed in a cast iron and sheet steel case. Working over the nozzles are deflecting hoods manipulated by a hand wheel in front of the switchboard. The wheel shaft is connected to that of the generator by a fly wheel link leather coupling. The fly wheel is six feet in diameter, and weighs 6000 lbs. The coupling is made by twelve links 6 ins. wide.

The entire electrical equipment was furnished by the Westinghouse Electric & Manufacturing Company. The generator is of the revolving armature type, rated at 500 kw. capacity, 550 volts and 60 cycles at 300 r. p. m. The generator is set on four blocks of granite which stand on the natural bed rock, and are well grouted with cement. The cables from the generator run under the main floor to the switchboard and thence to the transformers which are behind it. On a shelf against the rear wall and over the transformers are the lightning arresters. There is but one panel in the switchboard which, however, contains all necessary instruments.

The transformers, four in number, are of 125 kw. capacity each, and transform from 550 volts two-phase to 15,000 three-phase. High tension fuses are in a framework under the arresters. At one side of the building near the main water wheel, but on the station floor proper, is a 7½ kw. exciter, direct connected to a 12 h. p. Pelton water motor, mounted upon the same base.

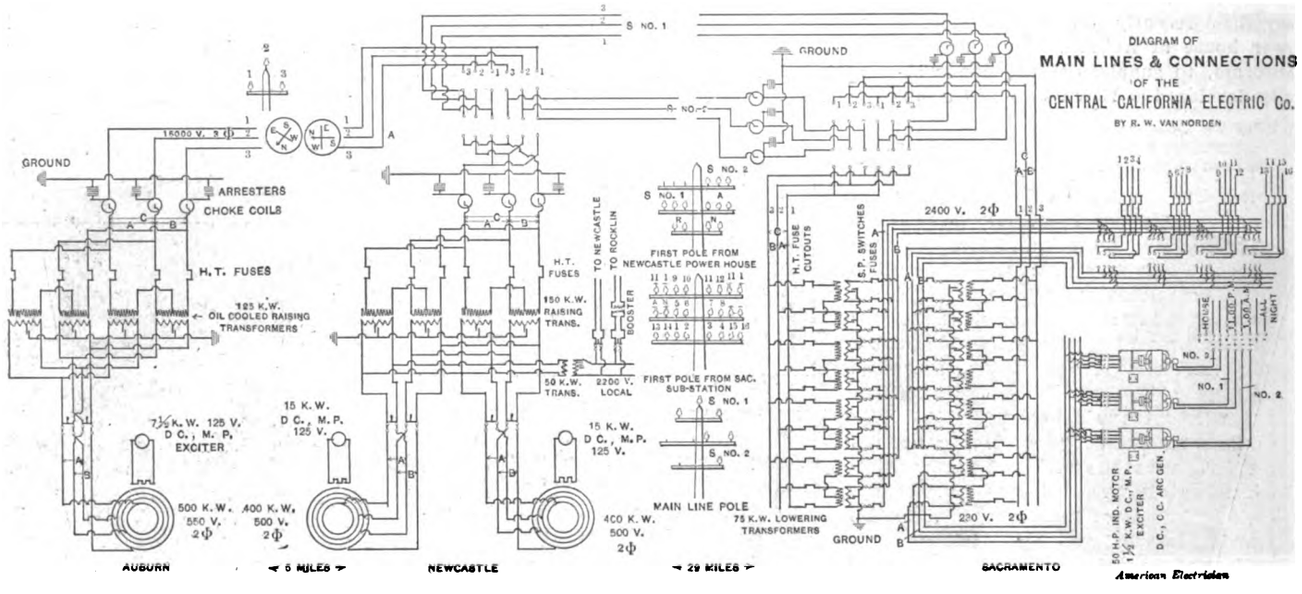
The regulation is done entirely by using the deflecting hoods before mentioned, which throw the water directly into the tail race. There is no attempt at saving water at low loads, as the flow in the canal must be maintained at all times. A bypass is provided to keep up the supply of water in the canal when the machines are not running. The main pipe is tapped near the rear of the building with an 8-in. gate valve, with a discharge pipe into the tail race; this, as well as the main pipe in the building, is imbedded in concrete to prevent any vibration or displacement. At the rear of the building a 12-in. gate valve in the main pipe discharges into the ravine. The exciter, main gates, regulator and switch board stand in the power house within a radius of six feet, thus facilitating hand regulation of all to the greatest degree.

The main transmission line consists of three No. 4 hard drawn copper wires supported on Locke triple petticoat glass insulators on locust pins, the latter being boiled in paraffin before using. The poles are of sawed redwood, 30 ft. high. The line runs directly to the New Castle generating station, terminating in a marble "plug board." This board has two panels and four sets of three plugs each. The New Castle and Auburn plants are arranged to run in parallel, the current being transmitted to the city of Sacramento, which is twenty-nine miles distant from New Castle and thirty-four miles from Auburn. The synchronising lamps at Auburn are connected in, one on the transformer and one on the generator side of one of the main switches. In order to synchronise the two plants, current from the plant which is running is allowed to flow to the other station, stepping down through the transformers. The generator is then started, and the switches thrown in in the ordinary manner. There has been no trouble experienced; in fact, if the machines are not exactly in synchronism when the switches are thrown, they will pull together with apparent small effort. When the two stations are running together all regulation is done at New Castle, the station at Auburn carrying a fixed load, dependent on the position of the hoods in its wheel. This load is increased or decreased in 100 h. p. changes, as the total load may require, and at the direction of the man in charge of the New Castle station.

The diagram printed below gives the general lay out of the circuits from Auburn through New Castle to Sacramento with the arrangement of the wires upon the poles of the various lines. Among other things may be noted the ingenious arrangement of the "plug board" at New Castle, referred to above, which is shown in the upper part of the New Castle section of the diagram. By means of twelve plugs either the Auburn or the New Castle plants may be run on either of the transmission lines or both in parallel.

A similar plug arrangement is shown at Sacramento for operating either transmission line or both in parallel independently, on either bank of step-down transformers, or both in parallel. The location of fuses, lightning arresters, etc., if studied, will show an admirable fitness to the purpose of giving maximum protection with a minimum amount of apparatus.

We are indebted to Mr. Rudolph W. Van Norden for the particulars of the building and construction.




THE CIRCUITS OF THE TWO POWER HOUSES AND THE SUBSTATION OF THE CENTRAL CALIFORNIA ELECTRIC COMPANY.

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## A GAS ENGINE CENTRAL STATION AT BRADFORD, PA.

The Bradford Electric Light & Power Company, Bradford, Pa., has the largest equipment of gas engines for electric lighting purposes completed as yet in this country. The company contracted some months ago with Messrs. Westinghouse, Church, Kerr & Company for three gas engines of 125 h. p. each, and one of 200 h. p., to be built by the Westinghouse Machine Company, East Pittsburg.

The new gas engine equipment constructed under this order replaces four automatic high speed steam engines of the same aggregate power, two of which were belted to a jack shaft from which the dynamos were driven, the other two being belted direct to dynamos in a wing off the main engine and dyanmo room. Steam for the engines was supplied by four 100 h. p. horizontal return tubular boilers, fired by natural gas. The amount of gas consumed for these engines amounted to fifty-two cubic feet per indicated horse-power per hour.

A new and more convenient arrangement of the floor space in the engine room has been made by placing the four gas engines on one side of the main room and belting them direct to the dynamos. Two of the 125 h. p. gas engines drive the four arc dynamos, two on each engine. One of the alternators is so placed that if necessary it can be driven by one of these engines. The third 125 h. p. engine drives the second alternator, and the 200 h. p. gas engine drives a 125 kw. Westinghouse alternator.

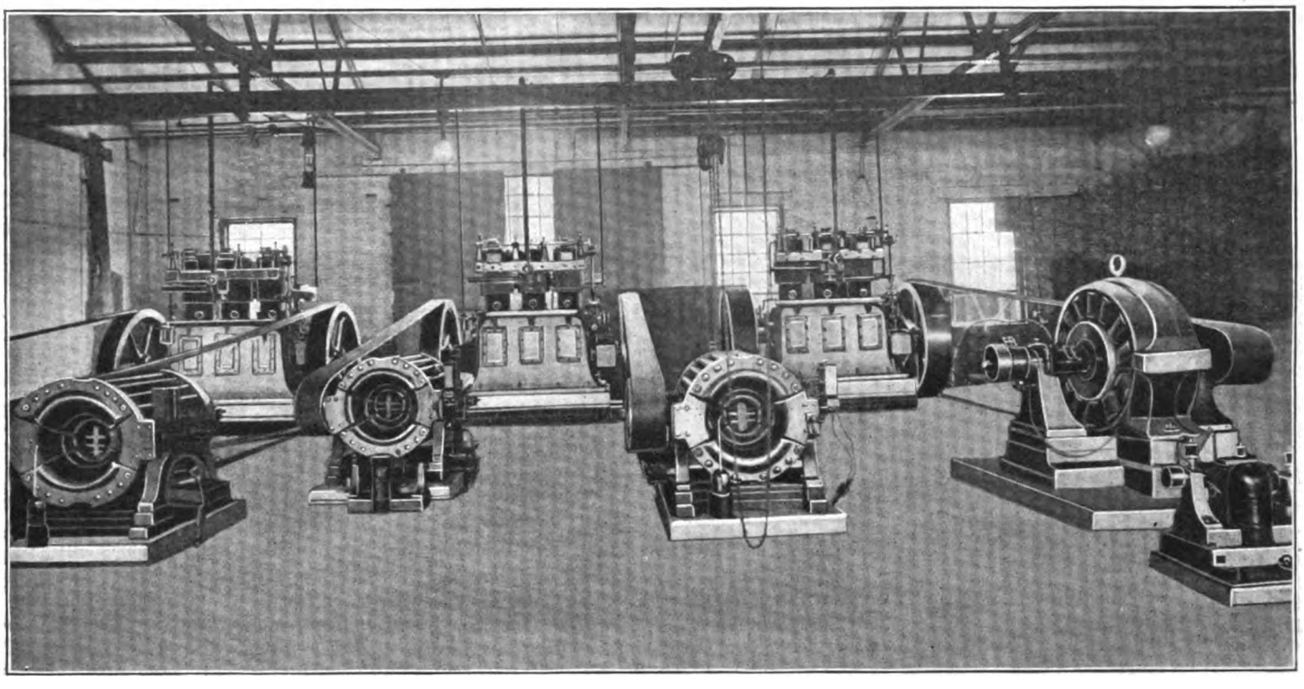
The Bradford plant is unique in that it is the first extensive electrical system in which steam power has been entirely displaced by gas engines. The fuel used is natural gas, of which the consumption is guaranteed by the Westinghouse Machine Company not to exceed thirteen cubic feet per brake horse-power hour. The saving in fuel alone, as compared with the former consumption of fifty-two cubic feet, will be a large item, and pay a handsome percentage upon the investment.

The floor space saved by the present arrangement of engines and dynamos, and the boiler space soon to be vacant, will be of value when additions have to be made to the present plant. The saving in boiler repairs, brick work and labor in boiler room is another considerable item. Better supervision is secured, as all the work is now concentrated in the one room.

A Clayton air compressor, driven by a small gas engine, is used to charge two air reservoirs placed overhead in the engine room. The compressed air is used to start the large gas engines. The small gas engine also operates a triplex pump which furnishes water to the jackets of the gas engines for cooling purposes. The small gas engine is equipped with a governor arranged for three speeds to accommodate the change of loads on the engines.

The view given above shows the plant before the reconstruction was completed, only three of the engines being in place.

At the present time it is too early to state what the average consumption of natural gas will be, but from records already taken the cost of fuel for one engine working 102 arc lights is about $1.12 for eight hours' service. The future working and development of this plant will be a valuable guide to users of power, and will be watched with keen interest.



THE CENTRAL STATION OF THE BRADFORD ELECTRIC LIGHT AND POWER COMPANY, SHOWING GAS ENGINES DRIVING ALL GENERATORS.

## PLEA FOR A WORKING STANDARD OF LIGHT.*

There are scattered over the country many well equipped photometric laboratories, and in the near future every central station and large isolated plant will be provided with means for measuring light. There is not now in existence any workable primary standard which can be used by the ordinary photometer corps.

A lamp user may say to the manufacturer, "Your standard is wrong," and neither ever dreams of suggesting a recalibration; they know by experience that an agreement can not be reached. No observer can even duplicate his own work. What is the result? Every lamp maker in the country is sending out some lamps which are wrongly marked according to his own standard, because some of his customers have standards of their own.

Lamp makers differ among themselves, and there exists no way by which they can be brought together. It is obviously to the interest of the whole electrical engineering fraternity that some action looking to the correction of this condition be inaugurated.

I wish to go on record as saying that in a very few years the incandescent lamp will be adopted as a primary standard. It could be so adopted to-day if lamp makers would only tell what they know.

A committee should be formed which would send out, under proper restrictions, proper seasoned and calibrated incandescent lamps for use as secondary standards. Such lamps, if carefully burned, would maintain their candle power constant and do away with the greater part of existing variations.

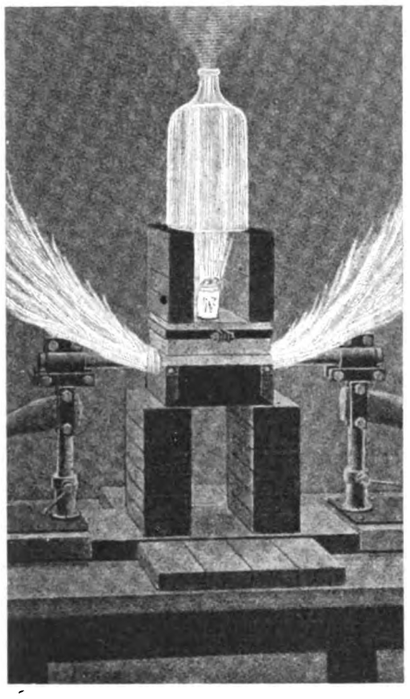
* Extract from a paper read before the American Institute of Electrical Engineers, Boston, June, 1899, by S. Everett Doane.

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## The Experimental Electric Furnace.

BY SAMUEL AUCHMUTY TUCKER, PH. B., F.C.S., OF THE CHEMICAL DEPARTMENT, COLUMBIA UNIVERSITY.

From the very earliest times it was found necessary to heat substances in order to bring about chemical change, and we know that every alchemist had his forge, which was used in the vain endeavor to transmute the baser metals into gold. This primitive method of heating has been changed with the introduction of gas, which is the usual accompaniment to every chemical laboratory, and indeed the modern gas furnace leaves little to be desired for all ordinary operations, but when higher temperatures are required, special means must be adopted. The discovery of the oxyhydrogen blow pipe gave us a very powerful source of heat, and many refractory substances were found to yield to its influence, for a temperature of 2000° C. is easily reached. A mass of platinum weighing 200 pounds has been melted at one operation by this apparatus. The calcium light is a familiar example of the use of this source of heat, the lime pencil being raised to a high

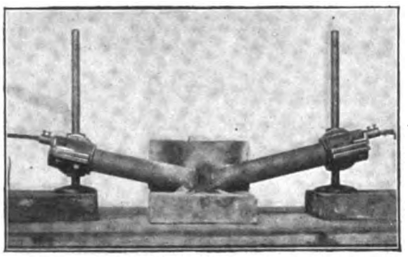


MOISSAN'S FURNACES, ARRANGED TO SHOW THE SUBLIMATION OF SILICA.

state of incandescence when the flame impinges upon it.

The electric arc, however, far exceeds other means for the production of high temperatures, and the ease with which it can be handled, enabling one to produce the heat instantly, makes it a most valuable addition to scientific research.

Every one is now familiar with the electric arc, but few realize what a very intense heat is produced; the carbon particles which form the arc are raised to such a temperature that practically nothing can withstand its effect. The temperature is probably the same in all cases where an arc is produced, that is the volatilizing point of carbon, but this temperature is by no means easy to estimate, for no thermometer or pyrometer can be used; and Violle, who has given us the most information on the subject, was obliged to resort to calorometric methods. His apparatus consisted of a powerful arc produced by a current of 450 amperes at 85 volts between two carbon rods one of which was formed into a button at the end, which could be easily detached; directly underneath this was placed a small copper vessel surounded with a given weight of water at a known temperature with appropriate heat insulation. After the carbon button had become thoroughly heated it was broken off and allowed to fall into the copper vessel. The rise in temperature of the water enabled Violle to calculate that for 1 gramme of carbon at the temperature of the arc to carbon at 0°C, 1600 calories are yielded up. Weber

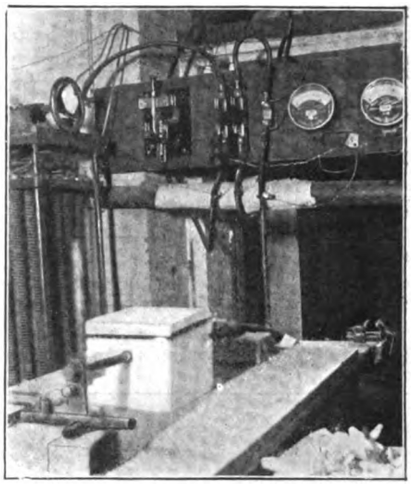


HORIZONTAL TYPE OF ELECTRIC FURNACE.

had already proved that 300 calories were necessary to heat 1 gramme of graphite from 0° to 1000°C, consequently there remains 1300 calories from 1000° to the volatilizing point of carbon; and knowing the specific heat of carbon to be 0.52, these 1300 calories represent a temperature of 2500°C, which added to the 1000°, equals 3500°C, which is at least the approximate temperature of the electric arc. It is readily seen that the method is open to several difficulties, for not only is there loss of heat by the fragment of carbon in falling into the calorimeter, but the specific heat of carbon probably varies at different temperatures. However, if we do not know the exact temperature we do know the effects which this form of heating is capable of producing, and they are indeed very remarkable. The use of the electric furnace has become very important in the last few years, for compounds are formed at the high temperature obtained which before were unheard of, and several industries have been established which have been the direct outcome of experimental research in the laboratory.

Henri Moissan stands at the head of this branch of the subject and his furnace is extremely well adapted to work of this kind; it consists of two blocks of chalk, one of which is hollowed out to hold a small carbon crucible, the carbon electrodes passing through two grooves horizontally; the other block of chalk acts as a cover and is cut so as to fit perfectly over the base.

The chalk on heating gives up its carbonic acid, becoming quicklime, which is



ARRANGEMENT OF APPARATUS FOR EXPERIMENTAL ELECTRIC FURNACES.

exceedingly resistant to high temperatures, but even this substance will melt at the temperature of the arc, and we have obtained beautiful crystalline pieces of lime while working with this furnace. At times, especially for continuous use, it is advisable to use layers of carbon in the form of plates separated from the lime by some magnesia, as magnesia forms no carbide.

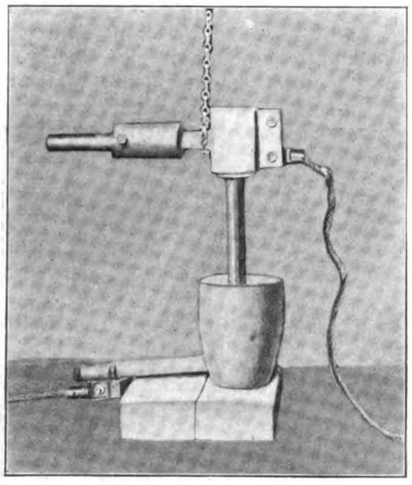
With this furnace Moissan investigated the many refractory substances with which we are familiar besides the production of carbides and rare metals, and carried on a very brilliant research into the nature of the different varieties of carbon, which led to the production of the artificial diamond. One great advantage which his furnace possesses, is that there is no electrolytic action, the substance to be treated being simply exposed to the radiant heat. A beautiful experiment, and one that well shows the high temperature reached, is the volatilization of quartz which may easily be made with the Moissan furnace. We have used powdered rock crystal which has been previously dried in an oven, a small quantity being placed in the crucible, a hole is bored in the cover to allow the escape of the gases and the current turned on. The best effects are obtained with a current of 300 amperes and 80 volts. The quartz melts instantly and is changed into gaseous silica, which passes through the hole in the cover and may be collected as a fine white powder on a glass cylinder placed above.

The illustration shows the arrangement of the apparatus, and we may judge of the degree of heat obtained when we consider that the parts of the metallurgical furnaces used in the manufacture of steel, are made purposely of silica bricks to withstand the highest temperatures in such operations.

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We have made the same experiment with a 20-ampere arc, using a small furnace and an ordinary lamp chimney to collect the silica upon, but generally a current of high power is required for this kind of work. In our own laboratory we have a direct current of 300 amperes at 110 volts, and the arrangement is here shown of the rheostats, switches, etc., which are used in controlling and reading the current.

The manufacture of calcium carbide, as well as the carbides of other metals, on a



VERTICAL TYPE OF ELECTRIC FURNACE.

small scale, is not difficult, provided we have a current of suitable power. These substances are particularly interesting and commercially important in the case of the carbides of calcium and that of silicon. Many of them decompose water with the evolution of acetylene gas, according to the reaction:

$$CaC_2 + H_2O = C_2H_2 + Ca(OH)_2.$$

And it was due to this very reaction that Willson, in 1888, noticed the formation of calcium carbide while making some experiments upon the production of metals by heating their oxides with carbon in an electric furnace. The substance itself had, however, been discovered by Wöhler in 1862, who obtained it in a totally different way. The table gives a list of the various carbides, with other information which may be useful.

| | Name. | Formula. | Discoverer. | Remarks. |
|---|---|---|---|---|
| Decomposed by water. | Aluminum | $Al_4C_3$ | Moissan, 1894. | Water evolves methane. |
| | Barium | $BaC_2$ | " 1894. | " " acetylene. |
| | Calcium | $CaC_2$ | Wöhler, 1862 | " " " |
| | Cerium | $Ce_2C$ | Moissan, 1896. | " " " ethylene and methane. |
| | Glucinum. | $Gl_4C_3$ | Lebeau, 1895. | " " methane. |
| | Lanthanum. | $LaC_2$ | Moissan, 1896. | " " acetylene, ethylene and methane. |
| | Lithium | $Li_2C_2$ | " 1896. | " " acetylene. |
| | Manganese | $Mn_3C$ | Troost and Hau'efeiulle | " " methane and hydrogen. |
| | Potassium | $K_2C_2$ | Davy, 1808. | " " acetylene. |
| | Sodium | $Na_2C_2$ | Berthelot, 1863. | " " " |
| | Strontium. | $SrC_2$ | Moissan, 1894. | " " " |
| | Thorium. | $ThC_2$ | Moissan, Etard. 1896. | " " acetylene, hydrogen, and hydrocarbons. |
| | Uranium. | $Ur_2C_3$ | Moissan, 1896. | Water evolves acetylene, methane, hydrogen, and solid and liquid hydrocarbons. |
| | Yetrium | $YC_2$ | Petterson, 1895. | Water evolves hydrogen. |
| | Zirconium. | $Z_2C$ | Moissan, 1896. | " " methane, acetylene and ethylene. |
| Not decomposed by water. | Boron. | $B_4C$ | " 1894. | Harder than corundum. |
| | Chromium. | $Cr_3C_2$ | " 1894. | " " topaz. |
| | Molybdenun | $Mo_2C$ | " 1893. | |
| | Silicon. | SiC | Acheson, Moissan, 1893. | " " corundum. |
| | Titanium. | TiC | Moissan, 1895. | Takes fire at red heat. |
| | Tungsten. | $W_2C$ | " 1893. | Harder than corundum. |
| | Vanadium. | VaC | " 1893. | " " quartz. |

Carborundum, or silicon carbide, is not decomposed by water, but its great hardness makes it valuable as an abrasive substance. For the preparation of calcium carbide we make use of the vertical style of furnace, which is really of the Willson type. The figure shows this furnace, and it simply consists of a plumbago crucible having one of the carbon electrodes passing through a hole bored in the side, the other being suspended vertically with some means whereby it may be easily raised and lowered. Suspension of this electrode by a chain and counterpoised weight is the best arrangement, for it admits of the arc being passed easily over the surface of the charge just as we might pass the flame of a blow pipe over anything which we wished to heat.

The charge is made up of 56 parts of quicklime and 36 parts of coke, both being finely powdered and evenly mixed. The vertical carbon is lowered until it forms an arc with the one through the side of the crucible and the material is gradually added. Good results are obtained by using a current of 150 amperes at 50 to 60 volts, and it takes but a few minutes to form a carbide ingot of fine crystalline structure. The operations may be watched through thick smoked glasses, but the greatest caution should be exercised while working with an electric furnace, for not only the eyes are in danger, but severe sunburn as well as sunstroke are not at all uncommon. For the preparation of chemically pure carbides it will be found advantageous to line the plumbago crucible with carbon, in order to prevent the introduction of any impurities from the clay which is always used in its manufacture. Aluminum bronze as well as ferro aluminum may be prepared in this furnace, or the electrodes may be arranged at an angle as shown in the illustration, the charge of alumina, coke, and copper or iron, as the case may be, being surrounded by fire clay bricks. This is really the manner in which these bronzes were first manufactured by the Cowles process, but at the present time it seems easier to make them by melting together pure aluminum with the necessary metal.

## THE CONSTRUCTION OF A CRADLE DYNAMOMETER.

BY PROF. A. F. M'KISSICK.

The cradle dynamometer, shown in Fig. 1, was built for the purpose of measuring the power delivered by a five-horse-power induction motor (mounted on dynamometer) to a belted dynamo, and, while the cost of construction has been small (not exceeding six dollars), it has been found

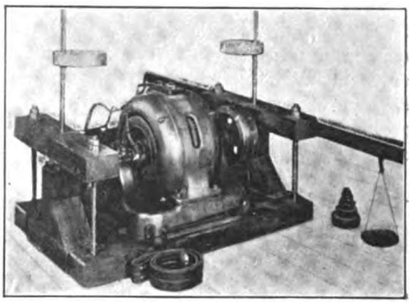


FIG. 1.—CRADLE DYNAMOMETER.

to measure the transmitted power quite accurately, and has proven very satisfactory.

The dynamometer was constructed chiefly of yellow pine (6 in.x4 in.), the knife-edge and support upon which the knife-edge rests being hardened steel, the vertical rods ¾-in. steel and the elliptical counter-weights cast-iron. On account of the belt being horizontal, some difficulty with a side pull was feared, but acting according to a suggestion of Prof. W. E. Goldsborough, in making the knife-edge and support, as shown in Fig. 2, no bad effects were experienced.

It is very important that the two knife-edges should be in line with the axis of

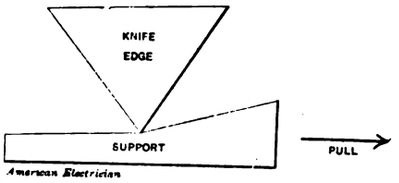



FIG. 2.—ARRANGEMENT TO RESIST BELT PULL.

the machine. An excellent device for setting the axis of the machine in line with the knife-edge is given in Flather's "Dynamometers and the Measurement of Power," on page 103, which is as follows:

"The device consists of two equal weights hanging from each end of a piece of belt, which is hung over the pulley of the machine. The weights together should, preferably, be about equal to the pull of the belt. The machine is adjusted so that hanging these weights on causes no change in the position of the scale beam, and any irregularity in the pulley is eliminated by trying it with the pulley in positions 180° apart."

By means of the cast-iron counter-weights the machine can be balanced, and also the center of gravity of the system be made to nearly coincide with the axis of the machine, being slightly below it.

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## THE INDEPENDENT TELEPHONE EXCHANGE OF THE LAFAYETTE TELEPHONE COMPANY.

It was in February, 1896, that the Lafayette Harrison Telephone Company began to serve patrons in Lafayette, Indiana, and at that time its exchange was equipped throughout with the Harrison International apparatus, including the Harrison switchboard. This entering of the field by a new company forced the Bell Telephone management to seek improvements, and they, in turn, refitted their local exchange with all that their skill and experience could discover to improve the service. It was hoped by them that the Harrison Company would prove but short lived, but in this they were disappointed, largely on account of the public feeling in favor of an independent company.

The exchange was then built to accommodate 350 subscribers, that being about 150 more than the city had ever before furnished. In a very few months it was found necessary to add another section of switchboard, and in an additional brief time another was required, and so on until accommodations for 800 were provided. Always on the lookout for anything that would better serve its patrons, the company installed the Beech-Cook transfer system on the old Harrison board, and a decided improvement in the exchange was at once noted.

But still the patronage of the company increased, and further improvements were imperative. The Lafayette Telephone Company, as it had come to be called, then fitted its exchange with the complete equipment of the Sterling Electric Company of Chicago, this equipment consisting of eleven 100-drop sections of switchboard, a distributing board for 1200 pairs of wires, chief operator and monitor's desk, and 11 combined cable terminals and protectors. Fig. 1 gives an idea of the appearance of the board, the distributing board being to the right of the switchboard. To the rear of the switchboard and distributing board can be seen the tops of the combined cable terminals and protectors, as they are located back of the board.

The chief operator and monitor's desk is situated in the middle of the floor and immediately in front of the switchboard. By means of this board the chief operator has constant supervision over the entire working force of the exchange.

The switchboard proper consists of 11 sections of Sterling metallic board of 100 drops each. The drops (see Fig. 2) are a bipolar tubular type, the armature being located midway of the spool concentrating both poles of the magnet at that point, thus deriving all magnetic force possible from the ampere turns, making a very sensitive drop. The core shield and armature are made of imported Norway iron stock. The winding is of single silk magnet wire, each spool having a resistance of 500 ohms. The drops are assembled on metal plates, five to a plate, twenty plates being mounted within each 100-drop cabinet. Each drop shutter is equipped with a restoring slide and under each bank of ten drops there is placed a restoring lever which operates the slide upon each and every drop in the bank of ten.

The jacks are mounted upon a fibre-faced hard wood jackboard, placed immediately under the drop panels. The jacks are of the bridging type and each jack is made of a body casting upon which are mounted three German silver springs, insulated with hard rubber bushings. The jack is held to place in the jackboard by means of a lock nut, placing the jack in from the rear of the board, and the lock nut from the face, this lock nut acting as the barrel to the jack and also the face upon the board. This arrangement is illustrated in Fig. 3. Each jackboard is equipped with 100 jacks, numbered to correspond with the drops directly above them. Immediately under the regular jackboard are placed the transfer jacks, which are used to transfer

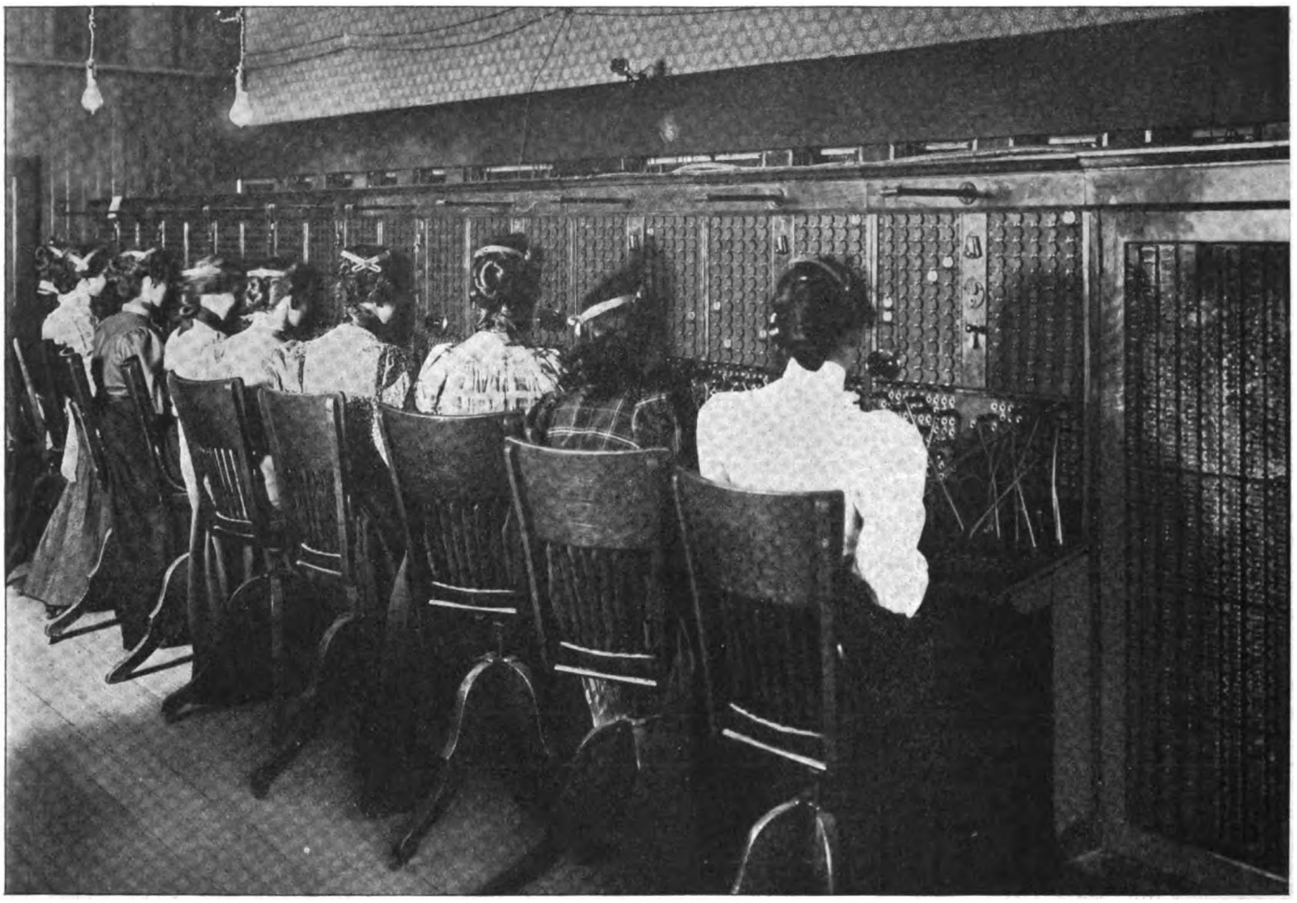


FIG. 1.—THE SWITCHBOARD OF THE LAFAYETTE EXCHANGE.

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connections to distant boards. These jacks (see Fig. 4) are of brass body casting, mounted in the same manner as the bridging jack, the structural details being different, however.

The keyboard, which is made of three-ply oak, placed upon an incline, is mounted with 10 pairs of metallic cords and plugs, 10 ringing and listening keys, and 22 transfer cords and plugs. The

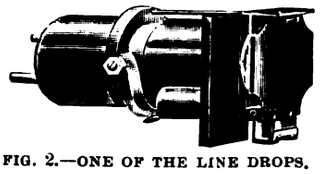


FIG. 2.—ONE OF THE LINE DROPS.

regular cords and plugs are for answering the calls upon that section of board, while the transfer cords and plugs are for putting up connections when called for from distant boards. Immediately in front of each transfer cord there is an order key for testing in upon a transfer cord. Each pair of cords is equipped with one long and one short plug, and the ringing and listening key consists of a cam lever and two push buttons, one push button ringing upon the inner cord and one upon the outer cord, there being but two positions of the cam lever, forward and back, which cuts in and out the operator's telephone set from the cord circuit.

Upon the falling of a drop the operator pulls the cam lever upon the ringing and listening key toward her, taking the short back plug, inserting it within the jack corresponding with the drop, restoring the shutter at the same time, putting up the connection with the front or long plug and ringing by means of pressing upon push button corresponding with that cord and plug, afterwards restoring the cam lever to place, thus cutting out the telephone set. When the parties talking ring off it is recorded by the falling of the shutter of the calling subscriber, which, in putting up the connection, is

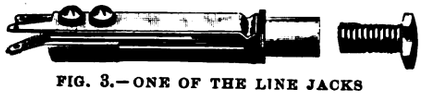


FIG. 3.—ONE OF THE LINE JACKS



FIG. 4.—A TRANSFER JACK.



FIG. 5.—ONE OF THE PLUGS

left bridged upon the circuit to be used as a ring-off drop.

The plug used is shown in Fig. 5, and is made of yellow brass, the tip of which is insulated from the body with hard rubber tubing. Between the connections at the base of the plug there is placed a fibre piece to which the connection of the switchboard cord is firmly lashed, taking the strain from the tinsel conductor. The handles are either of black rubber or fibre, have a shoulder turned upon the same to prevent slipping from the operator's fingers. The ringing and listening key (Fig. 6) is constructed upon a brass body casting, the mountings being heavy German silver springs and insulation of hard rubber, there being a dust-proof jacket fitting tightly over the same.

Immediately under the line drops in the drop panels there are located transfer drops (Fig. 7) which correspond in position with the transfer plugs and cords upon the section of board. Above the transfer jacks upon the jack panel are located order keys for calling the number desired to the distant board. This order key, which is illustrated in Fig. 8, is a brass casting within which are mounted German silver springs. The depression of the rubber button upon the same connects the two talking circuits of the two boards together, that is, the board upon which the order key is located and the distant board to which it is wished to communicate.

The transfer system which is used by

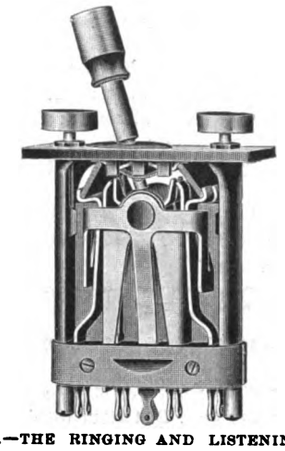


FIG. 6.—THE RINGING AND LISTENING KEY.

the Lafayette Company is what is called the Beach-Cook automatic transfer system. It is claimed to be the only automatic transfer system which independent telephone companies can procure. Its operation is as follows: Subscriber 5, calling upon No. 0 board, asks for 990. The No. 0 operator answers No. 5 with a short plug, placing the long plug of the same pair into the transfer jack leading to No. 10 board, depressing the order key at the same time connecting her talking circuit with No. 10 circuit, calling for 990. The insertion of the plug in the jack upon the No. 0 board automatically drops a shutter upon board No. 10, which corresponds with the transfer cord and plug which No. 0 operator wishes to be used in making this connection. No. 10 operator inserts this plug into jack 990, No. 0 operator calling the same by means of the push button upon the ringing and listening key in connection with the pair of cords upon her board. When the parties are through talking and ring off, this is recorded by the falling of shutter No. 5 upon No. 0 board. The operator immediately tests the connection, taking down the cords. This act automatically drops the shutter in connection with the cord and plug used upon board No. 10, which signals operator No. 10 that the parties are through talking, and to remove the connection.

Should either of the operators, however, through carelessness, remove the connection at one end and leave the same up at the other, there is in connection with this transfer system a hang-up drop and jack upon each board. Should the sub-

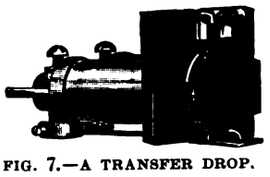


FIG. 7.—A TRANSFER DROP.

scriber who is left connected wish to call central, in doing so it will drop the drop upon the hang-up shutter, his own drop being shunted out by means of the plug in the subscriber's jack. The operator will answer this call by inserting the plug in the hang-up jack, thus learning what subscriber is hung up. Should the operator asking for a transfer connection be careless and allow a connection to be made with a busy telephone upon a distant board, the operator on No. 10 board can test in upon the connection by depressing a hard rubber button upon the transfer key corresponding with the cord and call the connection off by means of her order key to No. 0 board, requesting the No. 0 operator to take down the connection, as the parties are through. A diagram of the circuits of this transfer system is shown in Fig. 11.

The distributing board is located at the right of the switchboard, and is made up in strips 51 inches long, each strip accommodating 50 pair of wires. It consists of hard wood, hard rubber, black fibre, brass and German silver. The switchboard wires all terminate to the left upon each strip, the cable numbers to the right. The distribution or cross-connection is accomplished by means of short bridle wires, starting from the switchboard number, going to the rear and running from the horizontal or vertical lines to the strip



FIG. 8.—AN ORDER KEY

containing the cable number, coming through to the face at that point. It is a very complete, convenient and unique board.

The overhead construction of the Lafayette Telephone Company is good, being of No. 14 iron wire, the major portion of the plant being built upon 50, 45 and 40-foot poles, there also being some miles of 50-pair cable used. The instruments which are being used at the present time

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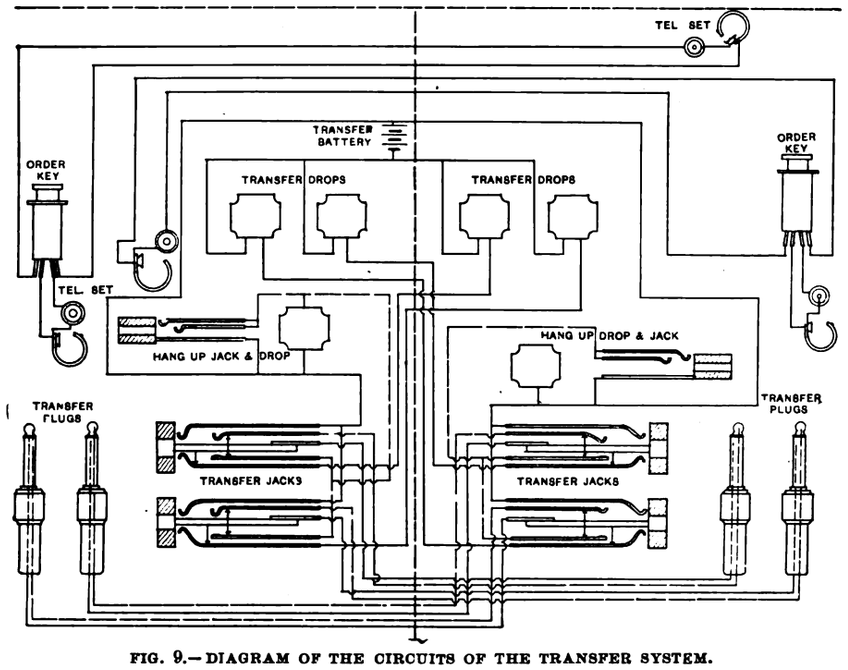



FIG. 9.—DIAGRAM OF THE CIRCUITS OF THE TRANSFER SYSTEM.

are assembled by the company itself, they purchasing what they consider the better portion of different instruments and assembling them as one.

The officers of the company are: Wm. Folckemer, President; Wm. Horn, Vice-President; Henry A. Taylor, Secretary and Treasurer; John F. McHugh, Counsel; Evan Shelby, General Manager; Directors, Wm. Folckemer, Wm. Horn, Henry A. Taylor, Leopold Dryfus and George P. Haywood.

## Among our Foreign Contemporaries

**A Direct Current Integrating Ammeter Without a Commutator.**—For registering the consumption of direct current there is now in use in this country practically only one meter, the Thomson recording wattmeter, even the Edison chemical meter having been quite completely displaced by the other instrument during the last few years. An ingenious meter for the same purpose in which there is no commutator and in which the friction of the recording dials is not a load upon the measuring device was recently described in "L'Industrie Electrique," the instrument being the invention of M. Blondlot. The general appearance of the interior parts of the meter is shown in Fig. 1, which, with a few words of explanation, makes clear the operation of the instrument. A and A are the coils carrying the main curent which passes in series with them through a suspended loop, B, hanging from a pivot, G, around which it is free to revolve. G and G′ serve as mercury cups to introduce the current to the movable coil without friction. Thus far the parts are similar to those of a Siemens electro-dynamometer, which this part of the instrument resembles in principle, the passage of a current tending to twist the movable coil into a plane parallel with that of the fixed coil. Attached to the spindle of the movable coil is an arm carrying a contact point, V, which strikes on the armature, R, of a magnet, E. When the coil, B, twists into the position to which the currents tend to force it, V closes a circuit through R and the high wound magnet, E, across the lines.

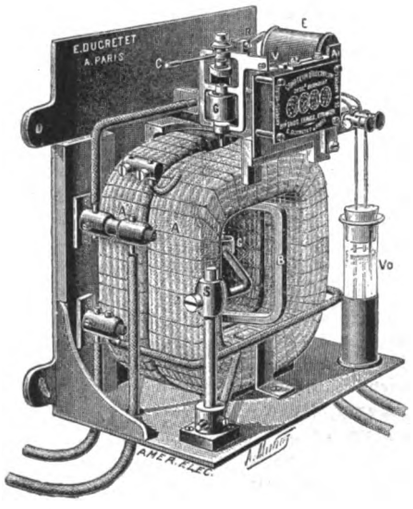



FIG. 1.—AN OSCILLATING COIL INTEGRATING AMMETER FOR DIRECT CURRENTS.

The magnet, E, then pulls up the armature, R, and with it the coil, B, and an impulse is given which throws the coil back toward the position shown in the figure. The coil is then twisted back again by the turning moment of the field set up by A on the currents in B, making another contact at V, getting another impulse from E and so on as long as a load is carried by the meter. The accuracy of the instrument as a measuring device depends upon the principle that the number of oscillations of the coil, B, in a given time is proportional to the square of the force which the coil, A, exerts upon it. As the current passing through both A and B sets up a magnetic force between these two coils proportional to its square, the frequency of the oscillation is exactly proportional to the current. In other words, the quantity of electricity passing through the instrument during the time of one oscillation is a constant, no matter how quick or slow that oscillation may be. All that is required, therefore, to make the instrument complete is a ratchet wheel, driving the recording dial and moved forward one tooth by every motion of the armature of the magnet, E. It is obvious that as the force between the fixed and movable coil is proportional to the quantity measured, the instrument could be used as a wattmeter by making either coil a potential winding. Sparking is minimized at the contact points by shunting a water resistance $V_0$ around the magnet.

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**Fusing the Neutral of a Three-Wire System**—Puzzling questions have arisen in connection with the advisability or inadvisability of fusing the neutral wire of a three-wire system. There are pros and cons, but after due consideration the rules adopted in Germany state that the neutral wire of a three-wire system or of a multiphase system, as also any bare wires which are intentionally grounded, are not allowed to be fused. Mr. Hess, in the "Elektrotechnische Zeitschrift," however, now shows that a case may arise in which fire could be caused by the fact that fuses are forbidden under these circumstances. In the case he cites the neutral wire is insulated from the earth; a good ground occurs in one of the outside wires and outside of the main fuse of a consumer; in the inside of the building a branch of small cross-section, forming part of the neutral wire, becomes grounded; when these conditions arise a fire may be produced by the heating of this branch of the neutral wire. The current due to these two simultaneous grounds flows through no fuse except the one at the central station or at the transformer and this, being a main fuse, may be too large to cut out the circuit, especially if the current in the building is from a branch wire of small cross-section connected with the neutral. He, therefore, concludes that fuses on the neutral are quite necessary when the neutral wire is not well earthed. On the other hand, there are other difficulties which may arise if the neutral wire is fused; it is therefore a question of the choice of two evils, of which the above mentioned seems to be lesser, and even that case

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can be avoided if the neutral wire is well grounded.

**The Board of Trade Panel.**—A peculiarity of switchboards of English traction power houses not found at all in American street railway plants is the Board of Trade panel, which is to English stations a feature resembling in appearance the total output panel of the American plant. The panel, or at least the instruments upon it, are to be found in all English railway plants, as they are required by what are known as the Board of Trade regulations. These require that the negative or grounded bus bar shall be connected with two special ground connections, independent of the rail returns, placed not less than 20 yds. apart and making such good grounds that an e. m. f. of 4 volts or less shall send through the earth from one to the other of them a current of 2 amperes or more. When these are connected to the negative bus, the current collected from the earth by them must not exceed either two amperes per mile of single track or 5 per cent. of the total current output of the station. Another requirement is that it should always be possible to reverse the direction of any current between the rails at any point and any pipe in the vicinity by interposing 3 Leclanche cells in series if the current flows from the rail to the pipe, or one Leclanche cell if the current flows from the pipe to the rail. Still another requirement is that the difference of potential between the most distant points of the rails and the negative bus bar must never be more than 7 volts.

A description of one arrangement of instruments on a panel designed to test these for requirements was recently given by Mr. J. Gray Scott in the London "Electrical Review," the diagram of connections being reproduced in Fig. 2. Here the two grounded plates specially provided for one test are connected to the two lower arrow-heads, which lead, as shown, to a double pole, two way dial switch at the lower part of the panel. By swinging the left-hand end of this switch up and the right-hand end down, a battery of two cells giving less than 4 volts is connected in series with the ammeter, $AM_2$ between the two grounded plates. According to the requirements given above, the ammeter should show more than two amperes. This test must be made at least once a month. Normally the dial switch is left with its right-hand end up, in which position the two grounded plates are connected in parallel through the recording ammeter, R A, with the negative bus bar. This ammeter is not what is usually called a recording instrument, but is better termed an integrating instrument in this country, but is really a recording instrument, giving a curve of the current at all time such as is obtained from a Bristol instrument.

Just above this dial switch is a cord and plugs and 6 plug sockets, one of which leads to the negative bus bar through the recording voltmeter, R V, while the others lead to distant rail points. This apparatus is for testing the requirement calling for a difference of potential between the most distant sections of the rails and the negative bus bar at all times

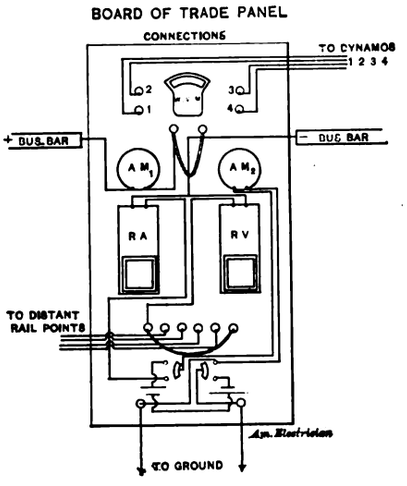



FIG. 2.—SCHEME OF CONNECTIONS OF BOARD OF TRADE PANEL.

less than 7 volts, a requirement which American traction systems would violate almost continuously. The other apparatus at the top of the panel consists of an ammeter and flexible cord for testing the leakage from the positive feeders, which is required to be less than 1/100 of an ampere per mile of track and must be tested daily or rather nightly when all cars are out of use.

**A French High Speed Vertical Engine**—The development of high speed engines has lagged in Europe far behind work in the same direction in this country, but

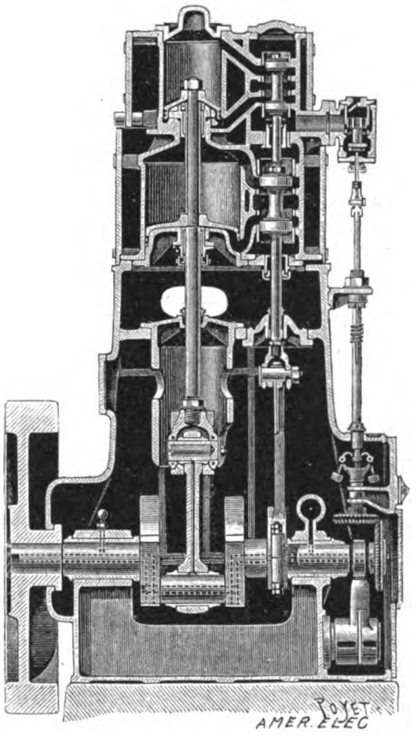



FIG. 3.—VERTICAL SECTION OF HIGH SPEED ENGINE.

some of the more recent designs show interesting details differing from practice here. "L'Electricien" describes a machine of this type designed by Messrs. Boulte & Larbodiere on the general principle of the English "Belliss" engine. A vertical section of the machine is shown in Fig. 3, in which it will be seen that the engine is double acting. The severe conditions of high speed service, notably the generation of heat at the main journals and the crank pin, as a rule render double acting engines out of the question for such work. In single acting engines the pressure is always downward upon the wearing parts and considerable play can be left in the brasses without pounding. If the engines are made double acting the brasses must be so tight to prevent pounding that they soon heat, and for this reason high speed engines are as a rule made single acting, whereby pressure is always delivered in one direction and the brasses can be left slack. Notable examples of such engines in this country are the Westinghouse and Willans. In the French engine, a vertical section of which is shown in Fig. 3, this difficulty is overcome by a novel and more efficient means of lubrication. This consists of a positive oil pump, shown attached to the right-hand end of the crank shaft, which delivers its oil into a passage through the shaft, cranks and crank pin themselves. This passage is shown by the dotted lines. From this central oil duct radial branches lead out to the wearing surfaces, journals and crank pin. Aside from this feature the design of the engine comprises a steeple compound arrangement of the cylinders with one gland between high and low pressure, cone pistons, piston valves, and speed regulation by means of a throttle valve controlled by a fly ball governor within the crank case. The rotating parts splash in oil and the case containing this oil is isolated from the cylinders and steam chests by means of an intermediate compartment open to the air, the piston and valve rod being packed both above and below this compartment. This allows any leakage of steam through the glands to escape to the air without entering the crank case, this feature resembling a similar arrangement on American horizontal high speed engines.

**A Magnetic Scale Collector for Electrolytic Baths.**—In the process of pickling forgings, plates and annealed steel parts to remove black oxide and scale a large amount of the latter material becomes detached from the iron, after which it gradually dissolves in the bath, using up acid that could otherwise be usefuly employed in cleaning the metal surfaces. The Cowper-Coles Company makes for use in such pickling baths a magnetic scale collector, consisting simply of a powerful magnet enclosed in acid-proof material. This, if placed in the lower part of the bath, quickly draws to it floating scale and magnetic oxide which by frequently lifting out the magnet can be readily removed from the bath. By this means a large amount of acid is saved.

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**Loss of Light in the Enclosed Arc.**—In order to determine how much light was lost by the deposits formed on the inner globe of an enclosed arc, Messrs. Gerard and Bast made what appears to have been a careful series of tests of a 108-volt, 4.5 ampere enclosed lamp, one set of the tests being made when the lamp was started and the globe quite clean, while the second set was made after the lamp had been running 103 hours. Their results are given in decimal candles, which are practically equal to our candles, or more exactly one carcel is equal to 9.62 decimal candles. They measured the mean spherical illumination as also the mean hemispherical below the horizon. At the start when the globe was clean the mean spherical candle power was 168.8, the mean hemispherical 199.8, the mean watts per candle being 2.9 and 2.45 respectively. At the end of the test, when there was a deposit on the globe, these figures were 129.5 for the spherical and 157.6 for the hemispherical intensities, while the consumptions were 3.71 and 3.047 watts per candle respectively. There is, therefore, a loss of about 16 per cent. in the spherical intensity and 20 per cent. in the hemispherical. The total life of one set of carbons was 110 hours and therefore the second series of tests practically corresponds to the end of the life of a set of carbons. These results were published in "L'Eclairage Electrique."

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**An English Switch.**—In England electric switches are comparatively rarely made of the knife and clip form so commonly used in this country, the contacts being as a rule of the laminated leaf type, similar to that used in General Electric circuit breakers. A new switch with this style of contacts and several other interesting peculiarities is shown in Fig. 4. The handle is attached through a quick break spring to a U-shaped piece, through which are passed several groups of laminated leaves, separated by distance pieces in order apparently to prevent them from crowding each other and to give increased cooling surface. The U-shaped piece is

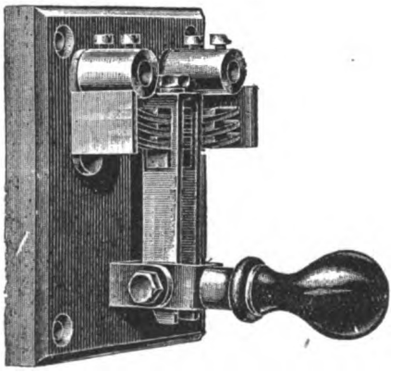


FIG. 4.—A MULTI-CONTACT SWITCH.

slotted in such a way as to allow the mechanical centering of the laminations between the contacts on either side. The laminations are readily removable and replaceable when burned out and the entire switch is made up of stampings so that it can be constructed at a low cost.

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**A Storage Battery for Traction Service.**—A description of the street railway line of Ghent, Belgium, appears in the "Elektrotechnische Zeitschrift," which contains an interesting description of the accumulator used. Each car is equipped with 108 cells, weighing about 2 tons, sufficient to drive the car 35 miles on one charge, and with the schedule adopted, requiring charging twice a day. The cells are of the new Julien type, the peroxide of the positive being formed electrically. The positive electrode consists of a block built up of many horizontal layers of corrugated lead sheets. A view of this block appears at the left-hand side of the illustration, Fig. 5. The sheets are laid up with the adjacent corrugation at right angles to each other, so as to give numerous channels, and a large space to be filled by peroxide. The plates are burned together at the corners. This block is perforated with 9 vertical cylindrical holes through which pass 9 cylinders, forming the negative electrode, which is shown separately to the right-hand side of the same illustration. These cylinders consist of per-

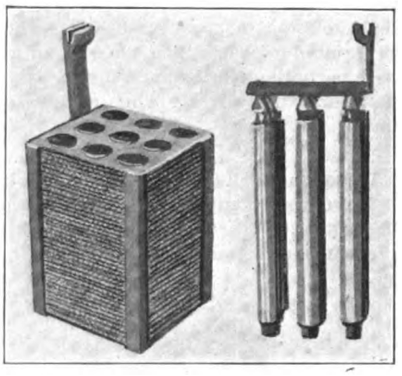


FIG. 5.—A NOVEL STORAGE CELL.

forated lead piping containing the negative active mass in the usual form of porous, spongy lead and of a volume bearing the correct proportion to the active mass of the positive. The negative cylinders are held out of contact with the positive block by means of perforated hard rubber insulating jackets. The performance obtained from this battery is as follows: A cell weighing 55 lbs., including acid, gave 300 ampere hours at a 15 ampere rate and 250 ampere hours at a 50 ampere rate. This high rate of discharge is due to the large surface obtained per lb. of positive material, but it would seem that this surface is quite inaccessible to the acid, and the battery would therefore require frequent rests during heavy discharge in order to allow the liquid to get into the recesses.

---

**A Circuit Breaker for Electric Cars.**—In an article on a German street railway system contributed by Max Schiemann to the "Elektrotechnische Zeitschrift," there is described a circuit breaker for use on cars, which is constructed on an ingenious principle which might prove valuable in other instruments. A view of it is shown in Fig. 6. The magnet coil ap-

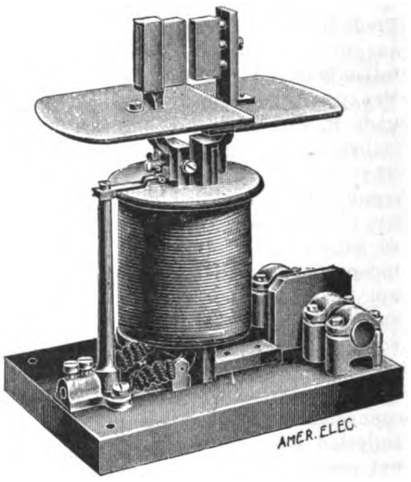



FIG. 6.—A STREET CAR CIRCUIT BREAKER.

pears in the center of the instrument and is evidently much more powerful than those designed simply to trip mechanical triggers of American appliances for the same purpose, the coil of the instrument having to accomplish all the work of opening the circuit by magnetic force. Passing vertically through the coil are two cores, one of which is fixed, while the other is hinged to the base. One of these carries a copper and the other a carbon contact at the top of the instrument above two protecting plates intended apparently to prevent the arc from striking downward. The opening of the circuit is accomplished when the current rises to such a strength that the two cores repel each other with sufficient intensity to overcome the restoring force. The beauty of the instrument is that the same coil that sets up the operating force delivers a field across the gap sufficient to blow the arc out sideways on the magnetic blow-out principle. This field is said to be sufficiently strong to render an opening of less than ¼ in. sufficient to break a 500-volt circuit carrying a street car overload.

---

**A Dynamo and Engine Clutch.**—The municipal electric light and street railway power plant at Plymouth, England, contains some interesting features, which were described recently in London "Engineering." The incandescent lighting is supplied by alternating currents and the two loads are carefully combined on the same engines so as to smooth out the load factor peaks of the two and make any engine useful on either the railway or the lighting system. This arrangement is practically the reverse of that common in this country; where, if traction and lighting are carried from the same station the two loads are carefully allotted to separate engines to prevent the fluctuations of the railway from disturbing the regulation of the

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lighting. This disturbance is eliminated in the Plymouth case by the use of a substantial storage battery. As the plant is direct connected each railway generator is coupled to a lighting machine of the same capacity, 100 kw., and both are coupled to a 150 h.p. engine, which, it will be noticed, is only sufficient in size to drive either one of them. As it is proposed to run the lighting at times from the storage battery by means of the two machines used as a motor generator, they are both coupled to one end of the engine shaft, rigidly fastened to each other and connected to the engine through a clutch coupling. The latter is of an ingenious type, shown in Fig. 7. Here A is the driving member fastened through the whiffletree, C, with two helical springs encircling the boss of the driven member, B. These springs are of steel, rectangular in cross section and one is wound right-handed and the other left-handedly, so that one will drive in either direction, their other ends being attached to A in the upper part of the illustration. The collar, D, can be slid along the shaft by means of a jaw manipulated by the operator until it forces the shoe, E. This twists the whiffletree, C, until one or the other of the two steel straps takes hold of the boss, B, depending upon which way the shaft is turning. The friction tightens the strap just as does the friction of a rope upon the drum of a windlass or hoisting engine. By means of this clutch the two machines may be brought up to speed by the engine and afterward driven by the storage battery on the railway generator, the engine being uncoupled and stopped.

**An Overhead Conduit System of Traction.**—It has often been proposed to drive electrical omnibuses or other automobiles without rails on ordinary roads and supply them with power from an overhead trolley. In fact, such a system has been designed and put into experimental use in this country, involving two wires on which a small carriage or trolley is pulled along by a flexible connection from the vehicle. A proposed conducting system for the same purpose, consisting of an overhead conduit, is described in "The Railway World," the system being introduced by an English company. Fig. 8 shows the cross section of the overhead conduit proposed. It will be seen that it is supported from a suspension cable which can be given considerable sag, like that of a bridge cable, from the tops of poles placed at considerable distances from each other as compared with the ordinary trolley poles. The conduit is an inverted U-shaped structure of papier mache, supported at frequent intervals by wires and yokes from the suspension cable. Within this conduit and to either side are the conducting rails supported on insulators and on these rails run the wheels of a small four-wheeled carriage, serving as a trolley. This carriage is of course connected by a flexible two-conductor cable to the driven vehicle below with sufficient slack to allow the ordinary deviation of the vehicle from a straight path immediately below the conduit. Some such system offers a promise of satisfactory financial results in country districts, where the cost of a track would not be warranted by the amount of traffic.

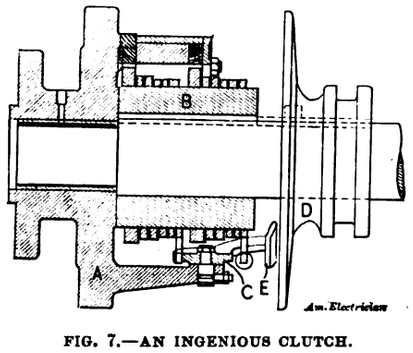



FIG. 7.—AN INGENIOUS CLUTCH.

**Contact Resistance of Carbon Brushes.**—In the elaborate serial on "Electric Generators," being published in London "Engineering" by Messrs. H. F. Parshall and H. M. Hobart, which, by the way, is by far the most complete and valuable work on the subject ever published, there recently appeared a discussion of the contact resistance of commutator brushes. A number of diagrams were given, of which one is reproduced in Fig. 9. This shows the remarkable fact that as the current density flowing across the face of the brush in contact with the commutator goes down the resistance of this contact goes up, so that the drop of voltage at this point is almost constant whatever the load of the machine may be within the limits of current density commonly used with carbon brushes. For instance, if the current flowing is 70 amperes per sq. in. the resistance of the contact is .0125 ohm per sq. in. and the drop is about .87 volt. If now the curent falls to 40 amperes the resistance rises to .021 ohm and the drop remains .84 volt, practically the same as before. This drop is that of one brush and must be doubled to give the total drop due to commutation. While the conditions of speed, brush pressure, etc., change somewhat this factor, the other curves given in the same article for other conditions coincide in character with that reproduced, but give higher values for the resistance, showing that the drop of the two brushes is at least 1½ to 2½ volts. This, it will be noted, must cause a serious impairment of the efficiency of 125 volt machines, this one loss being about 1½ to 2 per cent of the total output. The efficiencies of machies of higher voltages are affected to a lesser extent. The loss can be reduced in any machine over 90 per cent. by the use of copper gauze brushes as the lower curve shows.

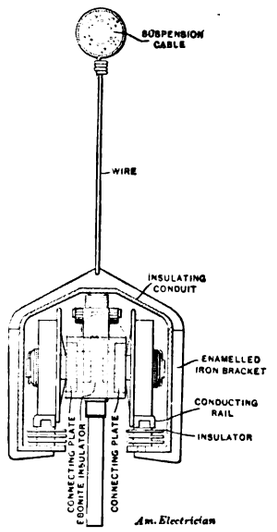



FIG. 8.—AN OVERHEAD CONDUIT.

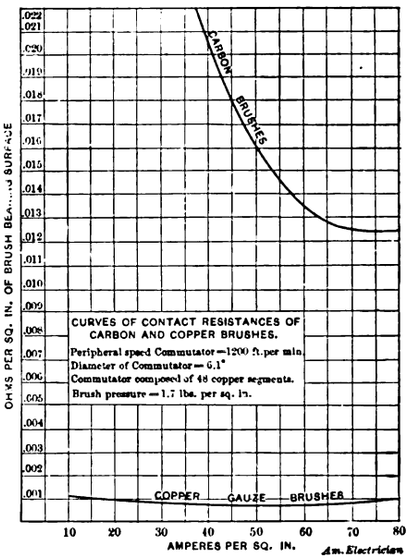



FIG. 9.—CONTACT RESISTANCE OF BRUSHES WITH VARIOUS CURRENT DENSITIES.

## NOTES.

**Anæsthetic Effects of Electric Currents.**—Mr. E. W. Scripture has published in "Science" a communication on the anæsthetic effects of high frequency alternating currents. It appears that with a current of about 28,000 alternations per second passing between the elbow and the hand a needle can be painlessly run into the forearm.

**A New Telephone Exchange in New York City.**—The New York Telephone Company opened on July 10th a new exchange known as the Madison Square, located on East 29th Street. The new office relieves the 18th and 38th Street exchanges, from which 1100 subscribers are gradually being transferred. This makes the fifteenth exchange of the company in old or lesser New York and the thirteenth on Manhattan Island.

**Street Railway Traffic Warranting Two Trolley Wires.** The traffic of the trolley cars over the Brooklyn Bridge is so heavy and the delay so serious in case of any failure of the conducting system that a

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double trolley wire—not positive and negative, but both wires positive—has been put on the up grades. The bridge has a heavy grade from each terminal to the center. The cars coast down by gravity from this point to the terminal, so that the failure of the wire on the down grades would not stop the cars. In case either wire breaks the trolley can be transferred to the other.

**City Water Pumping in the Plant of the Niagara Falls Power Company.**—The wheelpit of the Niagara Falls Power Company is recessed at a level of about 120 ft. below head water, with 4 great arched chambers cut in the rock. One of these is occupied by the oil and air pumping auxiliaries of the turbines and generators above, and the others are to be occupied by 6,000,000 gallon water pumping engines, for the service of the Niagara Falls Water Company, which is allied to the Niagara Falls Power Co. This will do away with the steam plant formerly used for pumping the water and occasion a considerable reduction of the cost.

**The Use of Aluminum in Printing.**—It may not be generally known among electrical engineers that aluminum, now exclusively manufactured by an electrical process, is coming into extensive use in place of the lithographic stone for printing purposes. In fact, a new word, "aluminography," has been coined to correspond with lithography. Some of the advantages of the new material are briefly the following: Durability, greatly diminished weight and storage space, and the ability to use the plates in rotary presses, as they can be readily curved to fit a cylinder. Several makes of rotary presses adapted for this work are now on the market.

**Punchings for the Single-Phase Rectifier.** In answer to the request in the last issue of the American Electrician for offers of castings, laminae and other parts suitable for the machine the design of which was published in the June issue of the American Electrician, Mr. T. Binford, of 994 Washington Boulevard, Chicago, Ill., offers to make dies for the armature laminae if there appears to be a sufficient demand. Mr. Binford proposes to make the laminae according to the specifications for a dynamo or motor as outlined in one of the queries and answers on page 396 of the last issue of the American Electrician. Readers who propose to construct such a machine are requested to correspond with Mr. Binford direct.

**Graduate Courses in Electrical Engineering at the University of Wisconsin.**—During the coming college year a number of new courses, some of which are suitable for graduate work and bring a second degree, will be offered at the University of Wisconsin. These will be divided between four separate specialties, viz., electromagnetism and the construction of dynamos, alternating currents and alternating current machinery, applied electrochemistry and electrometallurgy, and electrical installations. The University faculty contains a number of the best instructors in these lines, particularly the second and third, in which fields Prof. Dugald C. Jackson and Mr. Chas. F. Burgess are respectively well known through their original work and publications.

**An Excursion of Electrical Engineers to Switzerland.**—The British Institution of Electrical Engineers this Summer holds its convention abroad in the form of an excursion to Switzerland. The proceedings open Saturday, September 2d, with a visit from Basle to the power station at Rheinfelden, followed by an inspection of the works of Messrs. Brown, Boveri & Company at Baden. Four days will be spent at Zurich reviewing the Oerlikon works and plants of interest. From this point the itinerary leads to Schaffhausen, Lucerne, Interlaken, the Stansstad-Engelberg and the Jungfrau three-phase mountain railways and other points, the last date scheduled in Switzerland being Saturday, the 9th. Several hundred members are expected to be present on the trip.

**The Cost of Municipal Lighting in Detroit.**—The fourth annual report of the Public Lighting Commission of the city of Detroit, Mich., for the year ending June 30, 1899, has recently been sent out. The report may be summarized as follows: The number of arc lights has been increased from 1744 to 1868, in addition to which there has been a reduction of the cost of operation and maintenance, bringing the cash outlay per arc lamp per year down to $46.46. The fixed charges are figured as they were last year, viz., depreciation at 3 per cent. and interest at 4 per cent. on the total investment less amounts already charged off and loss of taxes at the city and county tax rates on the assessed valuation of the plant. Thus computed, the fixed charges chargeable to the arc service amount to $29.10 per arc lamp, making the total cost to the city per lamp per year $75.56.

**The International Electrical Congress.**—In connection with the universal exposition in 1900 in Paris, there will be held an international meeting of electrical engineers and scientists, preparations for which are already under way. French electrical engineers have appointed a commission of organization for this congress, which is now circulating applications for membership. The well known engineer, E. Mascart, is the president of this commission. The subscription for membership is 20 francs. The meetings of the congress will last 8 days, beginning Friday, August 18th, 1900. The programme has been divided into five general divisions, as follows:

1. Scientific methods and instruments of measurement.
2. The production of electrical energy, transformers, transfer and distribution, electric lighting, traction.
3. Electro-chemistry, electro-metallurgy, accumulators, electric furnaces.
4. Telegraphy, telephones and various applications.
5. Electro-physiology.

**The Cost of Exhaust Steam Heating.**—A report was recently made by Prof. J. E. Denton on a system of exhaust steam heating proposed by the Narragansett Electric Lighting Company, Providence, R. I., in which report many interesting figures in the form of estimates are contained, which may be abstracted in tabular form as follows:

| | |
|---|---|
| Volume of space to be heated | 25,000,000 cu. ft. |
| Estimated consumption of steam per hour, maximum | 110,000 lbs. |
| Average during winter months, per hour | 75,000 lbs. |
| Back pressure, maximum per sq. in. | 9 lbs. |
| Average | 6¼ lbs. |
| Increase in steam consumption of triple expansion condensing engines | 42% |
| In spite of an increase of the boiler pressure of | 50 lbs. |
| Cost of generating steam per 1,000 lbs. | $.19 3/10 |
| Total cost chargeable to heating | $ 20,615.00 |
| First cost of distributing system | 204,500.00 |
| 15% interest and depreciation | 30,675.00 |
| Cost of maintenance | 13,200.00 |
| Proportional share of interest and depreciation account of station cost | 16,500.00 |
| Incidentals | 8,775.00 |
| Profit, 20% | 10,530.00 |
| Proper income for steam sold | 63,180.00 |
| Square ft. radiator surface | 300,000.00 |
| Price per sq. ft. | $.358 |
| Estimated cost of heating by private boilers, including labor, per sq. ft. of radiating surface | .25 |
| Difference in favor of private heating per sq. ft. of radiating surface | .10 |

**The Westinghouse Company in England.**—Further details have been announced concerning the proposed plant for the construction of electrical machinery under the Westinghouse patents in England. A company has been formed, called the British Westinghouse Electric & Manufacturing Company, Ltd., with a capital of $7,500,000, of which $5,000,000 will be 6 per cent. preferred stock. The common stock will be taken by the parent American company in payment for its patents, good will, etc., while half of the preferred stock has been opened for public subscription to provide means for immediate expenditures in connection with the new plant, the remainder being reserved for future issue. A tract of about 100 acres has been secured in Manchester, on the banks of the ship canal. The buildings alone will have a floor area of 40 acres and will provide for the employment of some 5,000 men. The American company guarantees that the profits resulting from the business during the first two years will be sufficient to pay the 6 per cent. dividend upon the preferred stock. The prospectus of the new British company states that the net profits of the American company for the year ending March 31st last were more than $1,275,000, the value of the total output at Pittsburg being $7,140,000. The orders for Westinghouse apparatus in the United Kingdom and Colonies for the last year were given as amounting to $1,330,000.

**A Novel Selective Call System.**—Some of the Bell companies in the smaller towns are now installing a party line system having eight subscribers on one pair of metallic wires. For talking the

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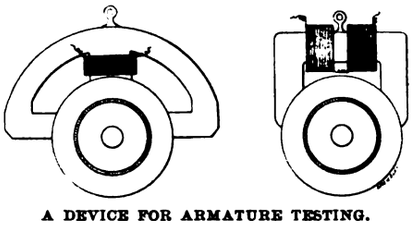
complete metallic circuit is used, but for ringing purposes one wire and the ground is used for four stations, the other wire and the ground for the other four stations. The subscribers' bells are polarized and so connected that a pulsating current in one direction over one wire returning through the ground will ring but two of the four connected on that wire, while a pulsating current in the opposite direction over the same circuit will ring the other two subscribers' bells. The four bells between the other line wire and the ground will be operated in a similar manner. At the central station a special motor-dynamo is used, from which can be obtained either an alternating current for ringing the ordinary bells or a pulsating direct current for ringing the party line bells in the system just mentioned. Whenever a ringing current is sent out over one of these party line systems two bells will always ring. Eight distinctive rings, one for each subscriber, are used. Two distinctive rings would suffice theoretically, but it is found more practical to use eight, as stated. At the switchboard there are four ringing keys, two for sending positive and negative pulsating currents respectively over one wire, and the other two for sending the same currents over the other wire, the ground being used in each case as the return circuit. As no device is used for locking out the subscribers not called, any subscriber may cut in at any time and overhear any conversation that may be taking place.

---

**A Steam Power Transmission Plant.**—An electric generating plant for supplying power for railways and mines in the Cripple Creek mining district in Colorado, very similiar to the plant of the Colorado Electric Light & Power Company in the same locality, described in the American Electrician of December, 1898, was officially opened on August 19th by the La Bella Mill, Water & Power Company. The power generating equipment is located in Goldfield, and like that of the other plant described above, is driven by steam power. The building is of masonry and steel and covers 10,000 sq. ft. The stack is of steel, self supporting, without guy wires, 12 ft. in diameter and 210 ft. high. The steam generating equipment consists of 6 Babcock & Wilcox boilers supported on steel girders over an ash tunnel and fitted with chain grate stokers. The coal is dumped from cars on an elevated track into inverted pyramidal steel coal bins hung from the roof. The flue runs through the basement to an economizer located under the pump room. The engine room contains an air compressor with a capacity of 5000 cu. ft. of free air per minute and three 750-h. p. cross-compound, horizontal Allis-Corliss engines direct coupled to General Electric three-phase alternators delivering 6000 volts direct from the machine windings with a frequency of 30 cycles per second. One common condenser is used of the elevated syphon type, with a cooling tower 110 ft. long, 20 ft. wide and 20 ft. high, mounted on an elevated piece of ground near the building. The whole plant is most carefully laid out, the steam and exhaust piping being minimized and other features thoroughly studied to obtain maximum economy and minimum depreciation. The work was in charge of Mr. L. L. Summers, who was retained as consulting engineer.

---

**A Simple Method of Testing Armatures.**—A means of very quickly and cheaply testing the insulation of armatures and instantly locating their faults, such as short circuited coils or wrong connections, is in use by the General Electric Company in the armature department at Schenectady. While the arrangement is of greater value to manufacturers than to consumers of electrical apparatus, it might well be adopted by street railway companies for motor testing and by large dealers for the testing of second-hand machinery. The test does not require the running of the armature, the internal electromotive forces being set up by simply generating an alternating field of force through it. The apparatus is shown in the accompanying sketch, the two figures being two different forms, one bipolar and the other what might be called a tripolar arrangement. The armature can be brought into position in any convenient way, under a magnet shown in the figure, which may be supported by a rope and counterweight. This magnet is of laminated iron and is wound with a coil excited by alternating currents. When energized it sets up internal electromotive forces in the armature conductors, which spread throughout the winding, tending to break down any weak points between the windings or segments of the commutator. A short circuited coil will be burnt out almost instantly. By giving the armature a part of a turn and repeating the process two or three times the whole armature can be thoroughly tested within a moment's time. The test is in its way a severe one, as the internal electromotive forces can readily be made much higher than those which the same armature can possibly generate when running as a part of a dynamo. If the magnet is of sufficient size to saturate the armature core and the frequency is 133 cycles per second, the electromotive forces set up will be much greater than the armature windings themselves can generate at the much lower frequency at which direct current machinery as a rule operates. The apparatus in either the two or three-pole form and with these poles located at any angles can be used on any continuously wound armatures except those designed for multipolar machines and fitted with special internal cross connections between points of equal potential. Since all the lines of force which enter the winding must leave it again, they set up balanced electromotive forces in simple continuous windings which would be short circuited by internal cross connections unless such armatures were provided with special testing magnets with poles corresponding in angular dimensions to those of the fields in which they are designed to run.



A DEVICE FOR ARMATURE TESTING.

---

**A Difficult Piece of Track Conversion** — There is now in course of construction on a section of Broadway, New York City, an open conduit track, the work on which is about as difficult an undertaking of its kind, outside of switches and crossings, as can be imagined. The Metropolitan Street Railway Company has had in use for a year and a half on this section its standard underground trolley track with control conduit and slot. The Third Avenue Railway possesses a right of way through the same street. To operate the latter company's line electrically and by the independent power system of the latter company, a separate pair of power rails in a separate conduit are needed. The existing conduit is therefore being pushed over to one side to give room for the other conduit beside it between the track rails. The difficulties are introduced by the fact that the track is being kept in service for the Amsterdam Avenue cars with a headway of about two minutes, and the conductor rails must, therefore, be kept "alive" throughout the progress of the work. The line runs all night, so that there is no opportunity to work while it is shut down. The change is accomplished as follows: The pavement is first removed and the heavy concrete foundation and conduit wall is broken up and removed piece by piece from around the yokes and live conductor rails, the track being shored up meanwhile to carry the heavy double truck cars which constantly run over it. Temporary wooden yokes are then inserted to maintain the gage of the track rails and the old yokes are loosened from them and pushed to one side, carrying with them the old slot rails, insulators and conductor rails. The conductor rails are then removed in single rail lengths and the free ends are fitted with outwardly flaring slippers to prevent the shoes on the plows of the cars from being carried away, the cars being allowed to drift through this open section. The old yokes are promptly removed and replaced by new ones fitted with appertures for the two conduits symmetrically placed between the track rails. The track as completed has only one pair of tramrails carrying the cars of both lines, the plows of one company going into one conduit to one side of the track center and those of the other company into the other. The work is constantly attended by shocks, short circuits and violent arcs, but the men become accustomed to these features and do not seem to mind them.

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### Synchronizing Lamps at the Engine.

In the operation of paralleling alternating current dynamos the adjustment of a fresh machine, just started up, to exact synchronism with those already carrying the load cannot be accomplished entirely at the switchboard, but, as a rule, requires the assistance of a man stationed near the engine. Some engines specially designed for alternating current dynamos are fitted with attachments by which the speed at which the governor tends to hold the engine can be varied up or down a few revolutions, but as a rule these are not necessary, and a fresh machine can be synchronized by simply manipulating the stop valve. This is due to the fact that the governor tends to allow the engine to run light a little faster than the others which are running with their load, since all governors in use on such services must slow down their machines as the load increases. This slight excess of speed can be readily shaved off by nearly closing the stop valve.

The assistance of the engineer in adjusting the engine to just the right speed is best guided by synchronizing lamps so located that he can see them. In direct coupled plants, as a rule, the switchboard is within plain sight from the engineer's position at the stop valve, but in belted plants—especially where the engines are on one floor and the dynamos on another—this is not the case. In one plant in New York City a lamp is placed in the engine room and connected to a plug on the end of a flexible cord hanging over the top of the switchboard upstairs. When a new machine is to be started one of the synchronizing lamps on the panel of that machine is removed and the plug is put in its place. The lamp down in the engine room then becomes one of the synchronizing lamps, the other remaining in operation on the switchboard to inform the switchboard attendant when to close the switch.

This device is a very effective one and constantly used, but is rather slipshod for regular switchboard practice. The same result might be obtained with permanent wiring by using a multi-pointed dial switch of the type commonly used for transferring a voltmeter from circuit to circuit, the switch being properly wired to the engine room lamp and to the synchronizing transformers of each machine.

### Heating by Means of Exhaust Steam.

One of the severest trials of central station men, especially in the large cities, is the isolated plant which does the lighting and motor work of the largest and in many ways the best consumers. The competition of the isolated plant exists almost entirely because of the use in connection with it of exhaust steam for heating. It is argued, and correctly, that the steam must be generated throughout the greater part of the year and might just as well be used for driving dynamos—supplying the lights and running the motors—on its way between the boilers and the heating system. The coal consumption is not materially affected, a certain amount of labor is required in either case and the added cost of the complete plant is less than the charges of the central station for the same service. If the central station were in a position to supply the exhaust steam for heating as well as the power for lighting and motors it would, when favorably located near a business center containing several office buildings with such plants, be able to add greatly to its motor and lighting load, as well as obtain a revenue for an otherwise wasted by-product, exhaust steam. It is hard for the central station contract manager to prove to the owner of a proposed building that the station can light and run its elevators for less than it would cost an isolated plant to run over and above the cost of heating, but it is comparatively easy to compete with the more definite figure of the total cost of running an isolated plant. Such business is, as a rule, profitable at comparatively low rates, owing to the fact that it is concentrated among a few comparatively heavy consumers, easy to reach electrically and to collect from financially, as compared with widely scattered small loads.

A factor which should often be considered in the rates to be charged for exhaust steam is the increased consumption of the engines per horse-power hour. A report on a proposed district steam heating system of Providence, Rhode Island, appears on another page of this issue, according to which the change from condensing to an average back pressure of 6 lbs. gage would increase the steam consumption of high economy engines 42 per cent. over and above any incidental saving and in spite of a considerable increase of the boiler pressure. There appears to be very little published information on the subject of the effect upon steam consumption of a variation of the back pressure, but what there is points to results comparable with this estimate. Theoretically, the change of the back pressure from 2 lbs. absolute to 6 lbs. above the atmo-

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sphere would nearly double the steam consumption of a theoretically ideal engine taking steam at a boiler pressure of 150 lbs. The reason for this effect can readily be understood by considering an indicator card, in which a change from condensing to non-condensing cuts off about 13 lbs. of the effective pressure the whole length of the stroke, which must be made up by a considerable increase of the length of the admission line. The argument is advanced by some of the advocates of exhaust steam heating that this is easily compensated by raising the boiler pressure the same number of pounds as the back pressure is raised, which is generally an easy thing to do. This argument is entirely wrong, as a little consideration of an indicator diagram will show. The same mean effective pressure must be maintained if the same work is to be done. If the back pressure for the whole length of the card is raised 20 lbs., the forward pressure must be raised on an average the same amount. If the initial or boiler pressure is raised 20 lbs., the cut-off remaining the same, the expansion line will come down at release to within a few pounds of the old expansion line, and the needed m. e. p. will not be obtained. As a rule, to maintain the same consumption of steam with the increased back pressure given above, the initial pressure, if 100 lbs., must be raised to about 150, and if 150, must be raised to about 250. Even this requires a greater fuel consumption, as less water is evaporated per pound of fuel at the higher pressures, and as a rule the whole boiler and engine equipment would have to be altered for such a change.

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It may be safely estimated that a change of the back pressure from a condenser vacuum to that required for district heating will increase the steam consumption of an engine, if it is single expansion and has a low boiler pressure, by at least 100 per cent., and if it is compound and has a higher boiler pressure, at least 50 per cent. It is therefore unsound to argue, as is commonly done, that no part of the cost of the fuel should be charged to the exhaust steam heating, since, as is commonly argued, the steam is required in any event for the engines. If, on the other hand, all of this increased amount of exhaust steam is required for heating and the charges therefor are made to cover the cost of all the fuel, the effect on the engine efficiency of course makes no difference whatever.

**Motor Driven Centrifugal Pumps.**

The customary methods of pumping water by means of electric power involve as a rule more or less complicated electrical controlling and regulating apparatus for obtaining the proper pressure or flow under different demands, which apparatus may be largely done away with in many instances by combining suitable pumps with properly wound motors. As a rule the pump is required to maintain constant pressure with a variable flow, a requirement to which the positive action or piston type of pump at constant speed is by nature most poorly adapted. In water-works, hydraulic elevator or ordinary house service, the control is, as a rule, obtained by using a tank or pneumatic accumulator and stopping and starting the pump, or worse, opening and closing a bypass by means of a float controller.

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The advantages of centrifugal pumps for such service do not begin to be appreciated as they should be. A centrifugal pump maintains a nearly constant pressure when run at constant speed over a wide range of flow, from zero discharge up to its capacity. This action can perhaps best be described by a reversion of the old time analogy between the flow of water and that of electric current. Just as a shunt-wound dynamo, when driven at a constant speed, tends to lift an electric current, so to speak, through a practically constant number of volts, whatever the number of amperes passing through it may be within its capacity, so a centrifugal pump tends to give to the water passing through it a nearly fixed difference of pressure whatever the number of gallons per minute may be. This action is quite different from that of piston pumps, which, when run at constant speed, raise the pressure higher if the delivery is impeded so as to force the same amount of water through it, and which, if the reduction is sufficient, compel some part of the electric or hydraulic system to break down.

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Like the dynamo, the centrifugal pump absorbs less power as the flow through it is checked, the analogy failing if the flow is reversed, as the purely centrifugal pump will not become a water motor. Also like the dynamo, there is a drop of pressure due to internal friction or resistance with increased demand, which with ordinary pumps amounts to about 20 per cent. between no discharge and that of maximum efficiency. On account of the increased load with increased demand the motor may be readily differentially wound so that as the discharge increases the speed runs up to maintain the water pressure constant.

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On account of this property a centrifugal pump may be used to give a constant head to a system of piping without the use of a storage tank and will maintain its pressure under great variations of flow. The domestic water supply of Bakersfield, California is obtained by means of pumps driven by induction motors, which discharge directly into the mains, with no water tower, maintaining the proper head of 35 to 40 lbs. per sq. in. over wide variations of the flow allowed through them by the opening of consumers' taps. In many isolated plants there are motor driven pumps for maintaining a water service throughout the building or district served, the belts, gears, tanks, float valves, controllers, pistons and general complication of which could be entirely done away with by the substitution of small centrifugal pumps direct coupled to the motors. On account of these complications direct acting steam pumps with their excessive fuel consumption are generally used for small or intermittent work, the steam pump having the advantages of simplicity and partial automatic regulation of water pressure delivered lacking in the motor driven piston pump.

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At its best the centrifugal pump is rarely as efficient as the more complicated piston pump and its efficiency falls off rapidly with reduced flow, yet the inefficiency of belts or gears required for motors driving piston pumps and the losses involved in frequent starting and stopping may bring down the efficiency of the piston and motor combination to that of the direct coupled centrifugal set. When a bypass is used with a piston pump, the machine running constantly, part of the time against the load and part of the time free from it, but subject to all the internal losses, the efficiency of the piston pump is reduced, as it is also when the flow is varied by slowing down the motor by means of resistance. If the bypass is used as a leak, the pump being kept under pressure all the time and its flow adjusted by varying the opening of the bypass—as is done in some central stations where boiler feed pumps are driven by induction motors of which the speed control is difficult—the efficiency naturally falls to very low values under light deliveries.

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## SIMULTANEOUS TELEGRAPHY AND TELEPHONY AND THE CONSTRUCTION OF APPARATUS THEREFOR.

BY H S. WEBB.

The transmission of telegraph and telephone messages over the same wire at the same time is called simultaneous telegraphy and telephony. Before describing the methods of arranging the telgraph and telephone apparatus by which this simultaneous transmission can be accomplished it will be well to consider briefly some of the fundamental principles involved. Fig. 1 shows the connections for the ordinary Morse closed circuit system as used in this country for manual transmission of telegraph messages. Suppose the average speed is 25 words per minute, or about five signals per second, that is the current in the line increases from zero to its maximum value, remaining at this maximum value for less than one-tenth of one second, and then decreases again to zero, remaining at zero for about 1/10th second. This is repeated at the rate of about five times per second. The time required for the current to increase from zero to its maximum, or vice versa, will depend upon the relative values of the self-induction, electrostatic capacity and resistance of the line wires and apparatus.

It has been shown that in a circuit having negligible electrostatic capacity the time for a current to reach its maximum value increases as the ratio of the inductance to the resistance, i. e., T varies as L/R. So that in an overland telegraph circuit in which the electrostatic capacity is very small, the time required for the current to reach its maximum value can be increased by increasing the ratio L/R, and, of course, L/R is increased by increasing L or decreasing R, or both. We can easily increase L/R, but, unfortunately, with a given circuit we cannot increase L without increasing R somewhat.

Suppose we have a simple short overland telegraphic circuit, as shown in Fig. 1. When the key is closed to send a signal over the wire, the current will rise to its maximum value almost instantaneously and fall to zero again almost instantaneously when the key is opened. The current curve will be somewhat like that in Fig. 2, in which time is plotted along OT and the corresponding current in amperes along OI. The time required for the current to reach its maximum even on an overhead line 350 miles in length is less than 1/40th of the duration of a dot. If it is desirable to increase the time insert in the circuit some inductance, that is, a coil of wire wound over a soft iron core. Then the circuit would be as in Fig. 3, in which I and $I_1$ are two impedance coils. Now the inductance in the coils I and $I_1$ acts as a barrier to the inrushing current and prevents it from reaching its maximum value as quickly as before; the larger the ratio of the total inductance to total resistance in the circuit the more gradually will the current rise to its maximum value. Coils having inductance and used for this purpose, are called choke, retardation or impedance coils, because they choke, retard or impede the current.

The reason for this is usually explained as follows: The current in the coil creates in the iron core lines of force which increase as the current increases. This increasing of the number of lines of force generates an opposing or counter electromotive force proportional at each instant to the rate at which these lines are increasing, and, consequently, the resultant electromotive force, and, therefore, the currents reach their steady maximum values gradually and not instantly. Now the induction increases as the square of the number of turns in the coil, and the resistance increases about as the number of turns, from which it is quite evident that L/R increases rapidly as the number of turns increases.

Now when the circuit is broken at the key the rapid decrease in the lines of force threading the iron generates an electromotive force; but this time it is in the same direction as the original electromotive force, and, therefore, tends to resist the sudden decrease of the current, and, therefore, the current decreases gradually until the spark disappears, when it drops to zero instantly.

To make the increase and decrease in the current still more gradual two condensers, C and $C_1$ are connected in the circuit as shown in Fig. 4.

Now C and $C_1$ must become fully charged before the current in the line can reach its maximum value, and thus the rise of the current in the line to its maximum value is delayed, and, upon opening the key, the condensers tend to discharge their current into the line in the direction of the original current, thus causing the current in the line to decrease more gradually to zero. The current curve in the line can be made to approach the curve in Fig. 5 by using proper impedance coils and condensers.

At the rate of 25 words per minute there would be about 5 dots and spaces per second, or five curves like those in Fig. 5.

The induction coils and condensers will necessarily interfere with the use of any rapid automatic system of telegraphy, because the signals would be of such a short duration that there would not be time for the current to reach its necessary maximum value or to return to zero before a succeeding signal would be sent giving a curve somewhat like that in Fig 7. This

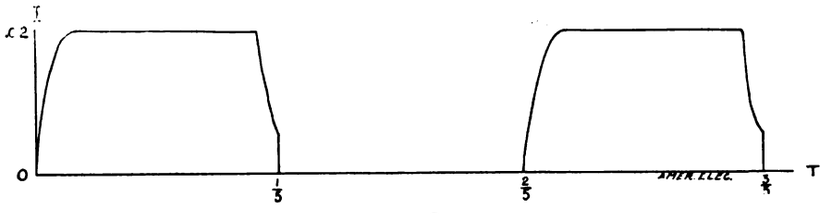



FIG. 2.

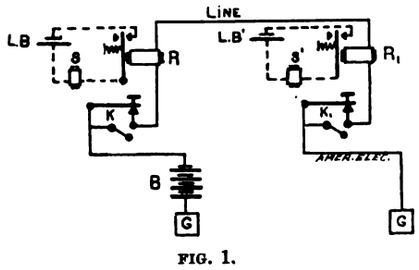



FIG. 1.

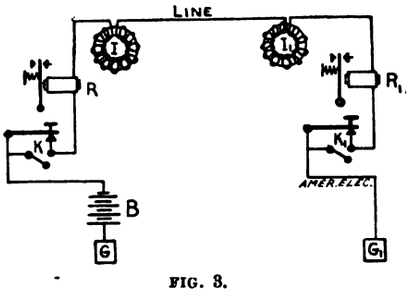



FIG. 3.

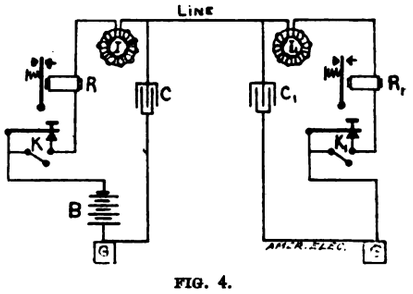



FIG. 4.

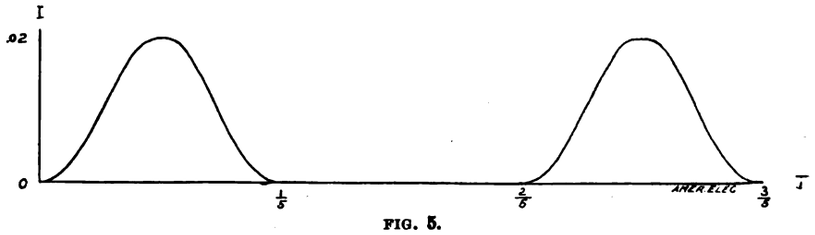



FIG. 5.

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message was made by a submarine cable syphon recorder, and such a current would not work a Morse relay properly. Moreover, even if suitable relays could be used, such rapid signalling would seriously interfere with what we are striving for, namely, to telephone as well as to telegraph simultaneously over the same wire. About the lowest audible musical sound is produced by 15 complete vibrations per second. Therefore, an undulating current which changes at such a low rate that it would never cause the diaphragm of a telephone receiver to move as fast as it would be moved by a current having a frequency of 15 periods per second, would produce no sound, not even a click, in the receiver.

Now if a telephone receiver, TR, with its induction coil, S, be connected to the circuit, as in Fig. 8, the telegraph current would go through the receiver circuit to earth in preference to passing through the line and through the distant impedance coil and relay, because the receiver circuit offers so much less resistance to the steady or slowly increasing and decreasing currents. And even if no sound was produced in the receiver still it is necessary, in order that the telegraph signals sent from station A shall affect the relay at station B, to prevent the telegraph current from passing through the receiver. To accomplish this a condenser is connected between the receiver and the line as shown at $C_2$. Fig. 9. It is a well known fact that a condenser will not allow a continuous current to pass through it, because its resistance to such a current is practically infinite. Therefore the telegraph currents will not pass through it, and, although it charges and discharges when telegraph signals are being sent, causing the receiver diaphragm to be moved to and fro, still the rate of change of the current is too slow to cause an audible sound in the receiver, as previously explained.

It has now been shown that the telegraph signals do not affect the telephone receivers. It then remains to be shown that telephone currents sent from station A will operate the telephone at station B, but will not interfere with the telegraph signals at A or B. In ordinary conversation 300 complete vibrations or periods per second is about the average frequency of the sound waves. By talking into a telephone transmitter, therefore, an alternating electromotive force is generated in the secondary of the induction coil whose average frequency is 300 periods per second. This rapidly alternating electromotive force in the secondary coil will charge and discharge the condenser, producing in the line wire an alternating current similar to that in the ordinary telephone line, as shown in Fig. 6. In Fig. 10 let curve A represent the slow undulatory telegraph signal current and B the rapid alternating telephone current. In the line these will be superimposed upon each other, producing a resultant from curve C, Fig. 10.

But why do not these rapidly alternating charges and discharges go to ground through the home telegraph apparatus and interfere with the telegraph signals, instead of operating the distant telephone? In the first place, even if all the telephone current did go through the home telegraph apparatus, it would not affect the signals, for the telephone current is probably less than 1/5000 as large as the telegraph current, so its effect upon the relay would be insignificant, as is evident from curve C.

Now, practically the whole telephone current will go over the line and through the distant receiver for the following reason: It is a well known fact that a circuit containing inductance offers greater resistance to the flow of an alternating current than to a direct current. The resistance of a circuit to the flow of an alternating current is called its impedance. For a continuous current $I = E/R$, but for a simple alternating current

$$I = \frac{E}{\sqrt{R^2 + (2\pi n L)^2}}$$

in both of which expressions I = current, E = electromotive force, R = resistance of whole circuit. $\pi = 3.1416$, n = number of double vibrations or periods per second, L = inductance, in henries, of the whole circuit. The expression

$$\sqrt{R^2 + (2\pi n L)^2}$$

is called the impedance. Now it is evident from this last expression that the impedance increases with the frequency n, and the inductance, L.

Suppose we calculate the impedance of a 500-ohm choke, or impedance coil. One that I made has an inductance L of about 8 henries for a current of 0.013 amperes, and if N = 300 periods per second then $2\pi n L = 15120$ and $\sqrt{R^2 + (2\pi n L)^2}$ = 15128, that is, the impedance of this coil is over 30 times as large as its resistance for a periodicity of 300. The impedance of a 250-ohm secondary coil is about four times its resistance. But the condenser in the telephone circuit tends to reduce the impedance of that circuit and therefore its impedence would probably be less than 1000. In the circuit with the 500-ohm coil there is also the relay, so that the total impedance of the telegraph circuit at one station in Fig. 9 is probably more than 50 times as great as that of one receiver circuit, and, therefore, most all the telephone current will pass through the line and the other telephone. To insure more satisfactory results the number of retardation coils and condensers are usually greater than shown in Fig. 9, and the circuits are arranged as in Fig. 11. I have also found it advantageous in some cases to connect a condenser of one or two microfarads capacity around the telegraph key and relay, as shown by the dotted lines in Fig. 11. This figure gives a complete diagram of connections for one complete metallic telephone circuit and two telegraph circuits over one pair of line wires, the ground being used as a return for the two telegraph circuits. The method so far described was invented and developed by Van Rysselberghe, an official of the Belgian telegraph service.

M. Cailho, a Frenchman, has devised

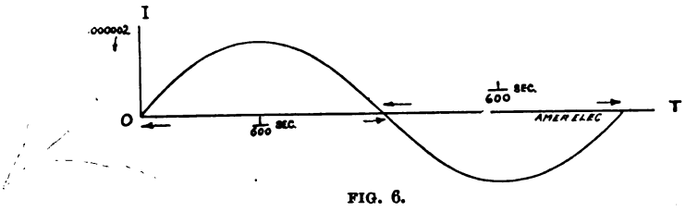



FIG. 6.




FIG. 7.

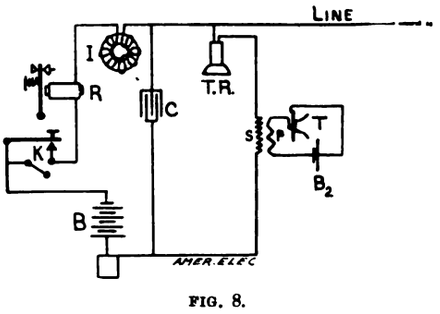



FIG. 8.

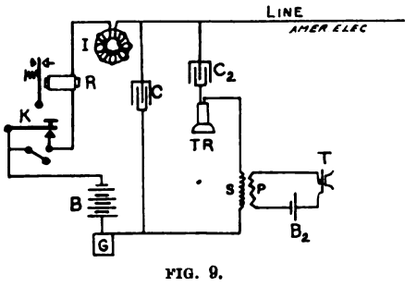



FIG. 9.

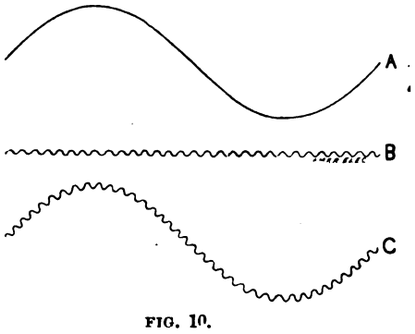



FIG. 10.

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a method whereby the two line wires forming one complete metallic telephone circuit are connected in parallel for the telegraph circuit, using the ground for the return telegraph circuit. In this method, which is much simpler than Van Rysselberghe's, only one telegraph message instead of two messages, as in the preceding system, can be sent over the two wires. M. Cailho's arrangement is shown in Fig. 12.

The coil A B consists of two identical

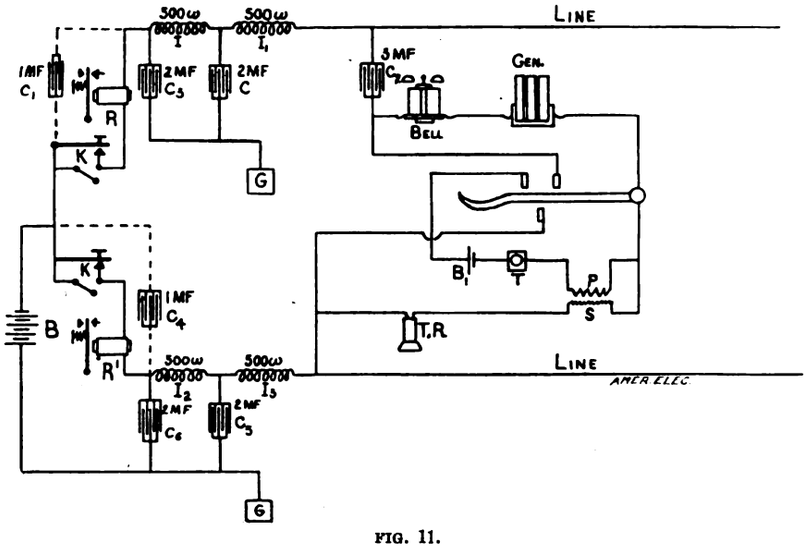



FIG. 11.

windings, A and B each having exactly the same resistance and the same number of turns and wound on the same soft iron wire core. This arrangement is similar to the bridge duplex telegraph system used on submarine cables. The telegraph currents divide at the point F into two equal parts, since the two paths have equal resistance, and pass through the two windings in opposite directions, so that the two coils tend to magnetize the iron core equally but in opposite directions, and, consequently, the self-induction will be practically zero, and the impedance to the telegraph circuit will be no larger than the ohmic resistance. For the telephone currents, however, the case is different. For the telephone currents would pass through the two halves A and B in the same direction and, consequently, the impedance offered by the coil to the telephonic current would be very large, thus practically forcing all this current through the telephone where it belongs. Thus the coils prevent the telephone currents from passing through them, but they do not interfere with the telegraph signals.

M. Cailho has successfully used coils of lower resistance, but the induction was made high. It is said that Morse relay magnets having a resistance of five or six hundred ohms may be used in place of the special coils. In this case the point F in Fig. 12 would be the junction of the two coils of the relay magnet. This method has the advantage that condensers are not absolutely necessary, and the extra apparatus needed is very much simpler than in Van Rysselberghe's method. Furthermore, the talking qualities of the telephone are not interfered with in the least and either regular series or bridging telephone bells may be used. If care be taken that the two halves of the coils A and B have exactly the same resistance and number of turns and the two line wires be reasonably equal in resistance, I have found that the clicks in the telephones will not seriously interfere with talking, although they may be heard. However, if the clicking is found objectionable it may be almost entirely obliterated by connecting condensers of one or two microfarad capacity around the telegraph relay and key at each station, as shown in Fig. 12. This system has been quite extensively used in France.

Of course in Van Rysselberghe's method two telegraph circuits can be operated over one pair of telephone line wires, or, by using the earth as a return for both telephone and the telegraph currents, then over a single wire, both the telephone and telegraph may be operated, while in Cailho's method over a pair of line wires there is only one telegraphic circuit in addition to the telephone circuit. In both systems high-resistance telegraph relays (150 ohms or higher) should be used, and in Van Rysselberghe's method half the necessary batteries should be located at each end. It will require 50 volts or more, depending on the line resistance, to furnish 20 milliamperes for the telegraph relays. Although I have not had the opportunity to try it, I believe that in Van Rysselberghe's method telephone induction coils having more turns in the secondary, say 500-ohm secondary coils, would work better than the ordinary 250-ohm secondary coils.

For the benefit of those who may desire to make the coils and condensers themselves, I will give here some directions which may be of service.

The two five hundred ohm impedance coils necessary at each end of the line in Van Rysselberghe's method may be wound upon one iron core, in which case care must be taken to connect the two windings to help and not to oppose each other. Practically this makes one coil of 1000 ohms resistance, with an additional terminal brought out from the middle of the coil. It may be made of No. 30 B. & S., double cotton-covered copper wire, requiring 9681 feet or nearly 3¼ lbs. for each 1000-ohm coil. No. 32 B. & S. wire would also do.

The core should be made of a bundle of soft iron wire, any size from No. 20 B. & S. to No. 25 B. & S. About 2 lbs. will be needed, and it must be cut up into pieces about 17 inches long. The middle five inches should be wrapped with linen or other insulating material, and two discs of cardboard, or, better still, wood or fibre, slipped on to form the ends of the spool, and securely fastened in place, leaving five inches between them for the coil of copper wire. Fig. 13 is a cross section of the completed coil.

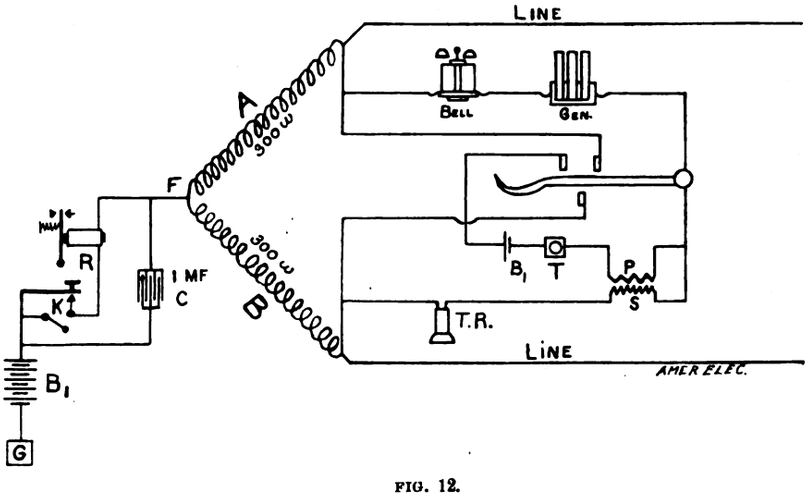



FIG. 12.

After winding on the 1000 ohms of wire the coil should be wrapped with linen and both ends of the iron wire core should be bent around over the coil, making the iron circuit as complete as possible in order to get the maximum inductance.

The coils for Cailho's method can be made in the same way. It will require

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about 1¾ lbs. of soft iron wire and 2 pounds of No. 30 B. & S. double cotton-covered wire for each coil of 600 ohms. The iron wire should be cut into 12-inch lengths, and the distance between the discs should be about 3½ inches. Two wires should be wound on together to insure having the same number of turns and resistance in each half. The outside terminal of the one coil should be connected to the inside terminal of the other. The winding should be wrapped with linen and the iron wire bent back over it, as described for the preceding coil. The iron core can be slipped into the lathe chuck and the copper wire wound directly on the insulated portion, or the coils could be first wound on spools made of thin wood or fibre and then slipped on the iron core. These coils could also be wound with No. 32 B. & S. wire.

### THE PARAFFIN PAPER CONDENSER.

The condensers may be made of alternate layers of paper and lead foil (which is cheaper than tin foil). Every alternate sheet of lead foil should project beyond the paper on one side and be joined together, the remaining sheets should project on the opposite side and be joined together as shown in Fig. 14. It will be well to make the condensers of one microfarad capacity each, and if more than one microfarad is required simply join the requisite number in parallel.

The capacity of a plate condenser in microfarads may be calculated from this formula

$$C = \frac{k \times s}{4\pi d \times 900\,000.}$$

in which K = specific inductive capacity of the insulating material, S = area in square centimeters, d = the distance between two sheets of tin or lead foil in centimeters and $\pi$ = 3.142, or, if S is expressed in sq. inches and d in inches and K = 1.7 for paraffin paper, then

$$C = \frac{2.54 \times S \times 1.7}{4\pi d \times 900\,000} = \frac{.000\,000\,38 \times S}{d}$$

The capacity of the finished condenser will only approximate the calculated result because d and K can only be approximately determined. 900 000 is a constant used to reduce it from the electrostatic unit of capacity to microfarads. It is well to use two sheets of thin paper between the sheets of lead foil, care being taken to reject any paper sheets having pin holes. Typewriter paper may be used for this purpose. It comes in boxes containing about 480 sheets, 10x9 in., costing about 45 cts. a box for the thin paper. Cheaper paper could be used. Two sheets are about .005 inches thick, but when paraffined will measure about .007. If c is to be one microfarad and d is .008 inches, then the number of square inches of lead foil required can be calculated.

$$S = \frac{.007}{.000\,000\,38} = 18420 \text{ square inches.}$$

Lead foil comes in pound packages containing 12 or 13 sheets 36x8 in. each. Each sheet may be cut into four pieces 9x8 in. and, allowing liberally for overlapping ends, there will be 7½x8 in. in each sheet. The number of sheets required will be

$$\frac{18420}{7.5x8} + 1 = 308 \text{ sheets or } \frac{308}{12x4} 6.4 \text{ lbs.}$$

say 6½ lbs. of lead foil per microfarad.

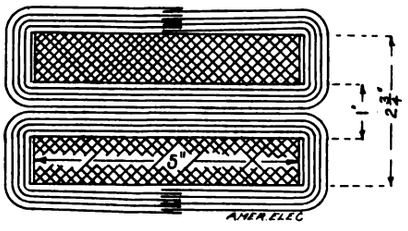



FIG. 13.

By getting paper 9 in.x9½ in., a more economical shape, one microfarad would require

$$\frac{18420}{8¼ \text{ x}8\text{x}12\text{x}4} = 5.7 \text{ lbs.}$$

Paraffin should be melted in a shallow dish large enough to allow the paper sheets to be easily dipped in it. If the paraffin is hot enough the air bubbles will

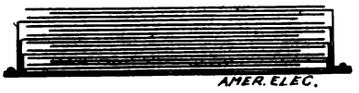



FIG. 14.

run off when the paper is removed from the bath, but care should be taken not to boil or burn the paraffin or singe the paper. The paraffin paper should be allowed to harden before laying it down.

Build up the condenser by laying down first two sheets of paper, upon this a sheet of tinfoil projecting ¾ in. over on the left, then two sheets of paper, then

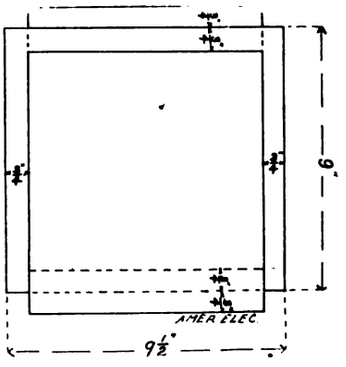



FIG. 15.

one sheet of tinfoil projecting ¾ in. over on the right. So continue to pile up all the paper and foil as shown in Figs. 14 and 15. It should then be pressed tightly together in a letter book press, placed into a shallow wooden box into which it will just fit, and the lid of which, when screwed down, will hold the sheets tight together. For terminals screw down a brass plate on the overlapping exposed ends of the lead foil. To this plate screw or solder a wire which should be brought out through a hole in the box, bushed with rubber tubing. Before screwing down the lid pour melted paraffin around the edges.

## INTERIOR WIRING.

### CONDUITS.

BY CHARLES E. KNOX.

So many changes and innovations have been made recently in conduits that it may not be inappropriate to consider, at this juncture, the various forms of electrical conduits which are used at the present time for interior wiring. Also the various rules and regulations governing their use, together with the requirements as to the covering on the wires to be used in the different forms of conduits.

All the forms of conduits used for interior wiring may be grouped under three heads:

1st—Rigid conduits with lining of insulating material.

2d—Rigid conduits without lining, but having an inner coat of enamel or similar material.

3d—Flexible conduits.

Before proceeding to consider each of these conduits separately, let us review the qualities which go to make up a good interior conduit and the rules and requirements formulated by the National Board of Fire Underwriters for the use of conduits in general.

First and foremost, a conduit for interior wiring should be fire-proof. This should always be the first consideration for any form or type of conduit. There is as a matter of fact no conduit in use today that does not fulfill this requirement. The reason for this is not hard to find, as there exists in every electric circuit for lighting or power, the elements necessary to cause a fire and every precaution should be taken to prevent the conduit from igniting and burning.

In the second place it should be moisture proof. That is to say, it should be of such material or construction as to not absorb or hold moisture and should be of such construction as would either prevent moisture from getting into the tube, or if it be possible, to rid itself of moisture condensing in, or percolating through, the tube by ventilation or by any other similar natural process.

Again it is desirable (although not essential) that the tube should be strong mechanically. It should resist nails, hard blows and should not easily be flattened by being walked upon or by having wheelbarrows run over it. In the modern fire-proof building the conduits are subject to hard usage, as they are frequently installed before the flooring is placed over them. In the days of the old unarmored paper tube and of thin brass armored conduit great damage was frequently done in this manner to the conduits and sometimes entire runs had to be replaced on account of flattened and damaged tubes.

Again, where the conduit is to be used in fire-proof buildings the armor of the conduit should resist the action of cement. The inability to withstand the action of cement on the copper was one of the weak points of the old brass armored conduit.

Again, the lining of the tube (if there

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be any lining) should be flexible, so that when the pipe is bent the conduit will not crack or break.

Lastly, the tube should withstand a "short circuit" on the wires which they contain, without disrupting.

The requirements of the National Board of Fire Underwriters in regard to conduits in general are as follows: (See "National Electrical Code," Rule 25 "a" to "f.")

a. No conduit having an internal diameter of less than five-eighths of an inch shall be used. (If conduit is lined, measurement to be taken inside of lining.)

b. Must be continuous from one junction box to another or to fixtures, and the conduit tube must properly enter all fittings.

c. Must be first installed as a complete conduit system, without the conductors.

d. Must be equipped at every outlet with an approved outlet box.

e. Metal conduits, where they enter junction boxes, and at all outlets, etc., must be fitted with a capping of approved insulating material fitted so as to protect wire from abrasion.

f. Must have the metal of the conduit permanently and effectually grounded.

Also (rule 49 a), each length of conduit, whether insulated or uninsulated, must have the maker's name or initials stamped in the metal or attached thereto in a satisfactory manner, so that the inspectors can readily see the same.

With the exception of e (and possibly f, in some cases), the above rules are worthy of being strictly complied with in all cases. If a good outlet box is used, there can be no object, so far as the writer can see, of using an insulating cap with the lined conduit at outlets. With the unlined conduit it may be desirable to use it. With either kind of conduit, however, it is well to use them where the tubes enter the cut-out cabinet.

Let us now proceed to consider each of the three groups of conduits separately.

1st—Rigid conduits with lining of insulating material.

In the supplement to the National Electrical Code of 1899 (issued quarterly) containing list of electrical fittings that have been examined and approved by Underwriters' National Electric Association, there are four makes of conduit approved under this head. These four makes are as follows:

Armorite Interior Conduit Company, Pittsburgh, Pa.

Clifton Manufacturing Company, Boston.

Consolidated Insulated Tube Company, Boston.

Sprague Electric Company, New York.

The Armorite interior conduit consists of an iron pipe lined with wood. The lining is made from live kiln dried bass wood cut with tongue and groove in two semi-cylindrical sections; thoroughly treated under pressure with a product of petroleum penetrating every pore and destroying the active properties of the wood excluding gases and moisture. The two sections are then placed together (over a mandrel) forming a complete tube, and forced into the steel armor. The wood can be cut any thickness, but is ordinarily cut, unless otherwise specified, 1/16 inch thick. The object in putting it in the tube in two sections is that it can be easily bent to any angle without affecting the pipe or wood lining. (Quoted from circular issued by Safety Armorite Co.) The objection which has been raised against this tube is that the wood lining is apt to crack in bending the tube.

The tube made by the Clifton Manufacturing consists of a standard iron pipe lined with vulcanized rubber.

The conduit made by the Consolidated Insulated Tube Company is very similar in material and construction to the Clifton conduit. Neither of these conduits have been used to any great extent. In fact, so far as the writer knows, their use has been almost entirely limited to the neighborhood of Boston. For this reason little can here be said of their practical merits or demerits.

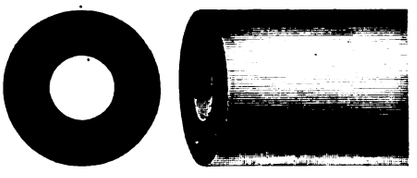


FIG. 1.—CONDUIT WITH HEAVY IRON WALL AND HEAVY INSULATING LINING.

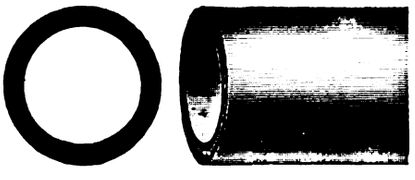


FIG. 2.—CONDUIT WITH THIN IRON WALL AND THIN INSULATING LINING.

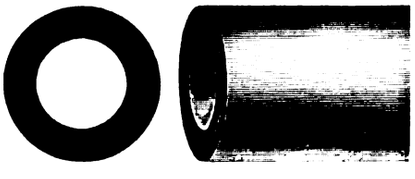


FIG. 3.—CONDUIT WITH HEAVY IRON WALL AND THIN INSULATING LINING.

The iron armored conduit made by the Sprague Electric Co. (formerly the Interior Conduit & Insulation Co.) consists of an iron lined with a tube of paper treated with an asphaltic compound. This tube is cemented or fastened to the inside of the iron pipe so as to form an integral part of the same. Cuts 1, 2 and 3 show the various evolutionary forms of this conduit. Figure 1 shows an iron pipe of standard thickness and diameter of ordinary gas pipe, with a thick insulating lining. This conduit was in use about three years ago. About two years ago the thickness of both the iron pipe and the paper lining were reduced and the conduit shown in Fig. 2 was the result. This was approved by the Board of Fire Underwriters and has been in use up to the present time. The Board of Fire Underwriters has recently passed a rule (see National Electric Code, Rule 49 b) that the metal covering of all conduits must be equal in strength and thickness to the standard gas pipe of the corresponding size. The insulating lining may, however, be the same as that used on the conduit shown in Fig. 2. This heavy armored conduit is shown in Fig. 3. This rule goes into effect on all contracts closed after July 1, 1899.

The new rules governing the use of these lined metal conduits with insulating lining, and which go into effect on all contracts signed after July 1, 1899, are as follows:

49. Interior Conduits. Metal Conduits with Lining of Insulating Material.

b. The metal covering or pipe must be equal in strength to the ordinary commercial forms of gas pipe of the same size, and its thickness must be not less than that of standard gas pipe, as shown by the following table:

| Size. Inches. | Thickness of Wall—Inches. | Size. Inches. | Thickness of Wall—Inches. |
|---|---|---|---|
| ⅜ | .109 | 1¼ | .140 |
| ½ | .111 | 1½ | .145 |
| ¾ | .113 | 2 | .154 |
| 1 | .134 | .... | .... |

An allowance of two-one-hundredths of an inch for variation in manufacturing and loss of thickness by cleaning will be permitted.

c. Must not be seriously affected externally by burning out a wire inside the tube when the iron pipe is connected to one side of the circuit.

d. Must have the insulating lining firmly secured to the pipe.

e. The insulating lining must not crack or break when a length of the conduit is uniformly bent at temperature of 212 degrees Fahrenheit to an angle of ninety degrees, with a curve having a radius of 15 inches, for pipes of one inch and less, and 15 times the diameter of pipe for larger pipes.

f. The insulating lining must not soften injuriously at a temperature below 212 degrees Fahrenheit and must leave water in which it is boiled practically neutral.

g. The insulating lining must be at least one-thirty-second of an inch in thickness, and the materials of which it is composed must be of such a nature as will not have a deteriorating effect on the insulation of the conductor, and be sufficiently tough and tenacious to withstand the abrasion test of drawing long lengths of conductors in and out of same.

h. The insulating lining must not be mechanically weak after three days' submersion in water, and when removed from the pipe entire, must not absorb more than ten per cent of its weight of water during 100 hours of submersion.

i. All elbows or bends must be so made that the conduit or lining of same will

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not be injured. The radius of the curve of the inner edge of any elbow not to be less than three and one-half inches. Must have not more than the equivalent of four quarter bends from outlet to outlet, the bends at the outlets not being counted.

We will now proceed to consider the next class of approved conduits:

2d. Rigid conduits without lining, but having an inner coat of enamel or similar compound.

The various makes of unlined enameled conduits approved in the "List of Electrical Fittings" issued by the Underwriters National Association are as follows:

Armorduct, Armorite Interior Conduit, Company, Pittsburgh, Pa.

Electroduct, Boston Electroduct Company, Beaver Falls, Pa.

"Loricated Pipe," Safety Conduit Company, Rankin Station, Pa.

As far as the writer can ascertain, these conduits are very similar and differ chiefly in the color of the enamel lining—not a very essential point. The iron tubes are smoothed and cleaned before being coated with the enamel and present a very smooth uniform interior after being enameled. It is claimed that these tubes can be bent without cracking the enamel, which is true if ordinary care is taken in making the bends. This conduit has the advantage over the lined conduit of being smaller in external diameter with the same inside diameter of the lined conduit. The latter conduit has the advantage over the unlined pipe, of being better able, on account of the lining, to resist the rupture of the pipe, which is apt to be caused sometimes by "short circuits" occuring on the branch circuits carried within the conduit. Fig. 4 shows an unlined enameled conduit of this class.

The rules of the National Board of Fire Underwriters governing the use of unlined metal conduits are as follows:

UNINSULATED METAL CONDUITS.

j. Plain iron or steel pipes of equal thickness, and strengths specified for lined conduits in No. 496, may be used as conduits, provided their interior surfaces are smooth and free from burs; pipe to be galvanized, or the interior surfaces coated or enameled to prevent oxidization with some substance which will not soften so as to become sticky and prevent wire from being withdrawn from the pipe.

k. All elbows must be made for the purpose, and not bent from lengths of pipe. The radius of the curve of the inner edge of any elbow not to be less than three and one-half inches. Must have not more than the equivalent of four quarter bends from outlet to outlet, the bends at the outlets not being counted.

3d. Flexible Conduits.

Under this head there are two conduits which are approved in the Supplement to the National Code. The first of these is the Circular Loom Conduit, made by the American Circular Loom Co., Chelsea, Mass.

The Circular Loom tube is constructed of a spiral of insulating fibre wound with a heavy Para rubber friction tape; over which is a continuous woven jacket of cotton similar to that used in the ordinary garden hose. The whole tube is then saturated with an insulating compound. After this the tube is dipped in,

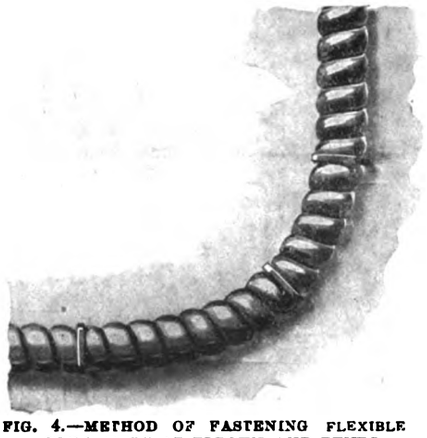


FIG. 4.—METHOD OF FASTENING FLEXIBLE STEEL TUBE AT ELBOWS AND BENDS.

or run through powdered mica, which makes it less likely to take fire.

The advantages claimed for this tube are that it is "flexible, water proof, it requires no joints or elbows, will not readily ignite, wires will not stick in it and it can be furnished in any length." As a matter of fact, however, it is not waterproof, does not resist the action of cement and wet plaster, and obviously it is not strong mechanically. For certain purposes, however, it is very useful, as for example in finished buildings, back of switchboards and other similar places. The rules of the Fire Underwriters practically limit its use to old or finished buildings of frame construction where it may be fished in between the beams and plaster and where it is not liable to the action of wet plaster or cement, or to injury from nails, etc.

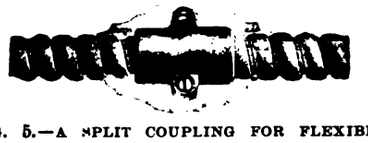


FIG. 5.—A SPLIT COUPLING FOR FLEXIBLE STEEL TUBING.

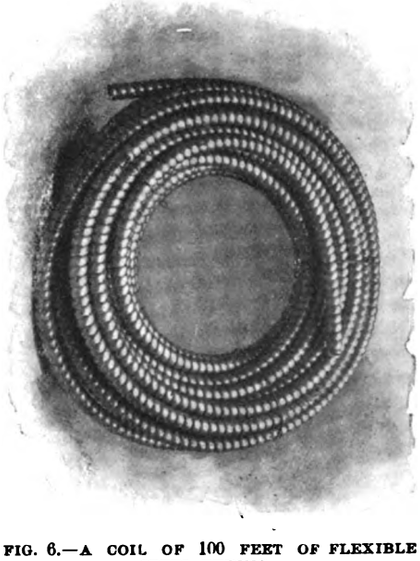


FIG. 6.—A COIL OF 100 FEET OF FLEXIBLE STEEL TUBING.

The Greenfield flexible steel conduit, which is approved by the National Board of Fire Underwriters is governed by the same rules as the unlined metal conduits. It is a new conduit introduced by the Sprague Electric Co. within the last six months. The conduit is described as a "conduit composed of convex and concave metal strips. These strips are wound spirally upon each other in such a manner as to interlock their concave surfaces, and present their convex surfaces, both exterior and interior, thereby securing a smooth and comparatively frictionless surface inside and out."

The advantages claimed for this tube are continuity, flexibility, ventilation and mechanical strength.

A continuous tube has a great advantage over a tube which comes in short lengths, as it avoids joints, couplings, etc., and can therefore be much more quickly installed. This tube comes in coils of 100 feet. Fig. 6 shows a coil of 100 feet.

Flexibility in a conduit is not always an advantage. In many cases it is very desirable, but sometimes it is a decided disadvantage. Of course it dispenses with elbows, as a bend of almost any radius can be made with this tube, with no other tools than the hands. But, mark this carefully, the greatest trouble may be caused by this flexibility, unless proper care be taken in installing this tube. It is of the utmost importance that each tube be securely fastened in at least two, and preferably three, points at the elbow. If this precaution is neglected, it will make it very difficult if not impossible to pull the wire through the conduit, because the tube will buckle and assume such shapes as to cause it to effectually bind or grasp the conductor, which is being pulled through the conduit. Fig. 4 shows the proper method of fastening this conduit at elbows and bends.

There is no doubt about this tube being a ventilated tube. If smoke is blown through one end of a short length of this pipe it will all come out through the fissures between the spirals before it reaches the other end. In many places this would be an advantage, as, for example, in exposed work, or in places where it would be concealed in cement or plaster. But it is very questionable that it is an advantage under tiled floors or in plastered walls where water (and other things beside) might get in the pipe, and where the ventilation would be reduced to its lowest limits. In such cases as these there is no doubt that a solid pipe with leaded joints would be much dryer and better.

The tube is quite strong mechanically, although not absolutely nail proof.

Fig. 5 shows a coupling for this conduit, and the method of using it with the conduit.

This new conduit will of course find its proper place in time. That there is a place for it there is no question, as for some particular purposes it is superior to any of the other conduits.

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## VALVE REPAIR TOOLS.

It has been stated in these columns that solid seat, metal to metal valves are the best while they last, but that they are very easy to damage by too much screwing down when closed. It is again in order to state that solid seat valves should have the disc merely touched down upon the seat when closed. Pressure applied after this only does damage and does not close the valve any tighter. The same is true with the soft packing valves, but they are not injured quite as much by the hard screwing process as are the solid seat valves. The principal cause of leakage in this class of valves is in the cutting or abrasion of the seat or disc, through being screwed against some hard substance. Perhaps an iron chip from a pipe thread is one of the most prolific causes of injury to solid seat valves. The presence of sand, boiler scale, or other earthly matter also spoils many seats and discs. Sometimes the partial closing of a valve against some soft substance, like a chip or a bit of string, allows steam or water to leak through and cause injury to seat or disc through cutting caused by the "sand-blast" action of water or other foreign matter which is carried along by the steam.

In all cases where solid seat valves are used provision should be made for the regrinding of the seat and disc or for the renewal of the closing surfaces by milling or filing the damaged surfaces. To this end a number of machines or devices have been perfected and placed upon the market, and several of these are illustrated herewith. In previous articles several types of "regrinding" valves have been illustrated and described. These are ordinary solid seat valves, made with solid discs, also, and so constructed that by means of pins or clamps the valve stem may be relieved from its screw and locked to the disc and the grinding effect-

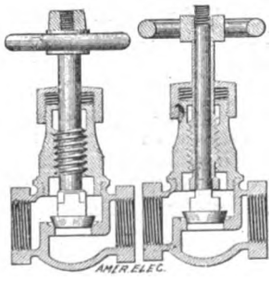



FIG. 1.—SPAULDING VALVE GRINDING DEVICE.

ed by rotary motion applied with pressure direct to the valve stem, the hand wheel being either grasped directly in the hand or caught by the chuck of a bitstock or a breast drill. In this kind of valve reseating the grinding is effected either by the use of grindstone dust, or, what is better, by the use of pulverized glass or silica sand. Emery is not good for this purpose, for, while it cuts away the metal very fast, it has an ugly habit of becoming so imbedded therein that it cannot be removed by any ordinary means, and continues to cut and grind while the valve is in use, thereby defeating the very purpose for which the cutting material was applied to the seating surfaces.

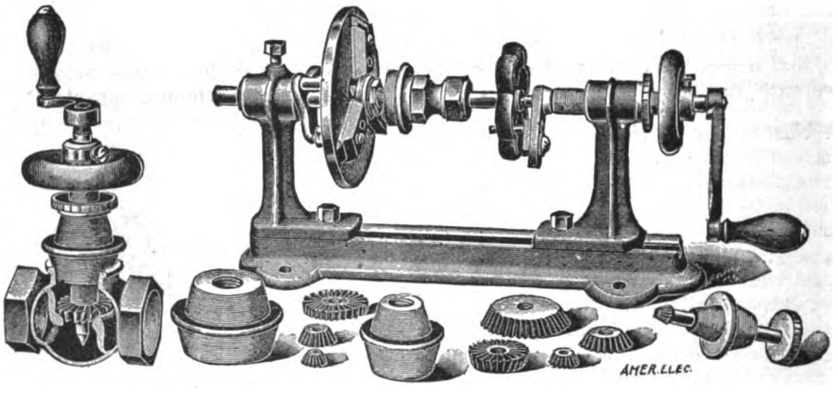



FIG. 4.—STANDARD VALVE RESEATING MACHINE.

Fig. 1 shows a valve specially constructed for this purpose, and as shown by the illustration the stem is independent of the screw, being placed inside a sleeve which carries the latter, and

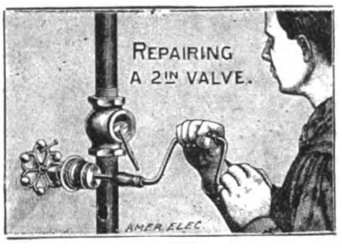



FIG. 2.—DRAPER'S VALVE FACING TOOL.

locked rigidly thereto by means of a cap nut at the hand wheel end and a shoulder collar near the disc. This valve was invented by A. R. Spaulding, Clinton, Maine, and possesses several points of

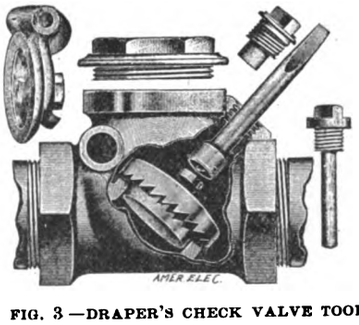



FIG. 3.—DRAPER'S CHECK VALVE TOOLS.

excellence. By attaching the valve stem to a bitstock, by means of a short plug hole in a tapped chuck, the disc, which can be locked to the valve stem, is rotated in the usual manner and the grinding prosecuted at any speed desired. For this purpose the hand wheel may be turned until the disc bears with any required pressure upon the seat. There is, then, no need of applying pressure upon the bitstock by the operation, but the hand wheel may be used to feed the disc down as fast as the disc or seat is ground away, or accordingly as the abrading material becomes reduced in cutting power.

Several types of valve repair outfits are made to be used with an ordinary bitstock, and the one shown by Fig. 2 may be taken as a fair representative of this class. It is simplicity itself, and comprises two bitstock tools for each size of valve. The engraving shows the whole operation so plainly that little description is necessary, except to state that the disc centers itself, no matter at what angle (within limits, of course,) the bitstock may be held. In cutting down the seat the file disc is so guided by the seat that it is quite easy to mill the surface thereof to a level condition. It is, however, possible to cant the tool and mill one side of the seat lower than the other, but this may always be avoided by proper care in doing the work. Some of this class of tools are provided with a taper threaded plug through which the cutting tool stem passes, thus allowing the same plug to fit several sizes of bonnet openings in different makes of valves. This tool is manufactured by T. Draper, Port Huron, Michigan. Another form of this tool, which belongs to the "valve-file" class, is shown by Fig. 3, and is used for repairing swing check valves. In this engraving both the application of the tool is shown, also the method of getting it into place, the reamer disc being separable from the stem, the parts being put in place from different directions. Here the seat forms the guide for the cutting disc, the joint in the stem serving as a ball and socket joint to render the disc independent of the movements of the stem and its connected bitstock.

It is easy to divide valve repairing tools into two general classes, in one of which the circular or segmental file is used; the other using a lathe tool for obtaining a surface. Either of these classes may be subdivided according to construction into several types, according to the method of application of the cutting tool, or to the manner of holding the work. In some types of the first class the so-called files, or reamers, have been developed into high grade milling cutters. This is particularly the case

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with the tool shown in Fig. 4, which represents the Standard Valve Reseating Machine, as originally manufactured by F. S. Dangerfield, Auburn, New York.

The taper bushing mentioned above is used in this machine, and several sizes are shown in the engraving thereof. Cutters are furnished, both flat and taper. There is a hand feed arrangement for small valves, and a large, positive feed device for use with the larger sizes of valves.

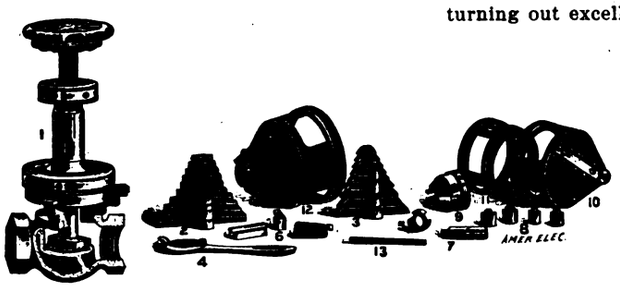



FIG. 5.—MORSE VALVE RESEATING MACHINE.

The hand wheel serves to feed the cutting tool, and the crank applies power for obtaining the necessary rotary movement. For regrinding the disc the mechanism above described is placed in a standard, which, in turn, is mounted on a small iron bedplate, the disc cutting arrangement is built up in an adjustable manner upon a face plate, as shown in the engraving. This plate carries a yielding dead center which serves to center the valve stem, then recedes before the valve as the latter is pushed up to the cutter by the feed screw. An opening in the face plate allows the wings of check valves to project.

Some of the "file-cutter" valve repair machines use only a narrow section of a cutting disc, virtually becoming machines of the class that use a lathe tool to do the cutting. But to reduce the number of types of machines as much as possible, this type will be here described as belonging to the "filing" or "milling" valve tools.

Fig. 5 represents what is known among engineers as the "Morse and Dexter" machine. It is put on the market by the Leavitt Machine Company, Orange, Mass., and is made in several forms, as shown by the succeeding engravings. As shown by Fig. 5, there is a tool which may be centered in the bonnet opening by means of a three-jawed internal chuck, and the seat ground by a positive feed of the milling tool, as already described.

Both straight and taper tools are provided for milling off flat and countersunk seats, and a number of small mills are supplied for the smaller sizes of valves. For turning up bevel discs the conical "pencil-sharpeners" are provided, and there is also a small chuck which is found useful in handling little valves. This form of valve machine is capable of turning out excellent seat surfaces owing to the great rigidity of the mechanism which attaches it to the valve, which, by the way, need not be removed from the piping when reseating is necessary. Three steps are provided on the internal jaws of the chuck, which are threaded to suit the bonnet openings. To ensure still smoother carrying of the stem, the sleeve in which it runs is split and fitted with a taper thread and nut wherewith all the lost motion is taken up and the cutting tool made to run without even the sign of a chatter. The conical reamer shells are threaded to fit the bonnet of a valve. The disc is then fed down by the hand wheel and screw, and rotated therein until the seating edge is brought to the required degree of perfection.

Another set, the Morse and Dexter machine, by the same maker as above, is shown by Fig. 6. In this machine the conical cutter is dispensed with and a small screw-driven slide nut carries a tool and is set at the proper angle to cut down the edge of a disc.

A horizontal machine, with a frame made of round steel, carries the disc turning device, and can be adjusted to almost any size of disc. Two internal chucks come with one of these machines. The slide rest tool, cutting at but a single point, reduces the irregularity of the disc without the possibility of springing the stem under heavy pressure, thereby turning out the best possible results.

Bushings for attaching different sized valve discs are also provided, as shown in the illustration.

Still another "Morse" outfit is prepared by the Leavitt Company, as shown by Fig. 7. This will dress both flat and bevel seats and discs from one-fourth to six inches in diameter, and the "universal cut" principle is used. The narrow parallel segment cutters, with cutting teeth at both ends, are employed, as described elsewhere in this article.

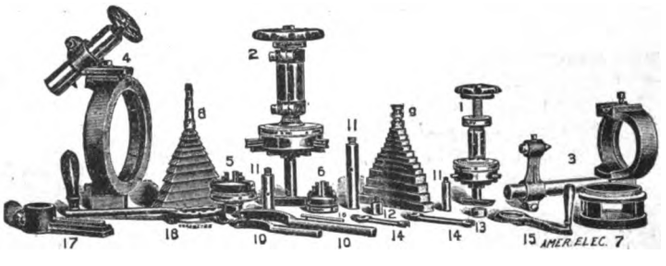



FIG. 6.—MORSE AND DEXTER VALVE MACHINE.

In this tool the bonnet, with contained stem, is screwed into a circular frame which carries three bevel cutters arranged like the jaws of a chuck, and by revolving the chuck ring by means of a spanner, thereby enables any size of disc to be turned up, a set of bushings being supplied for the very smallest bonnets.

A very simple, yet efficient form of the Dexter tool is shown by Fig. 8. In this the discs are chucked in the same tool which is used for turning up the seats. A circular frame carries the cutter, said frame being screwed into the vise when in use for cutting discs. When a flat disc is to be recut, the holder, 5, is put on. When seats are to be cut the tool is removed from the circular frame, a cutter, 3 or 4, is put in place of the disc and the device is fastened into the bonnet opening by means of the internal chuck already described.

A form of chuck is shown at 10 for use in attaching check discs and some other peculiar forms of valve discs.

By a recent improvement in this form of cutter greater stability has been given to the disc when in process of being cut, particularly when some of the "loose" discs are used.

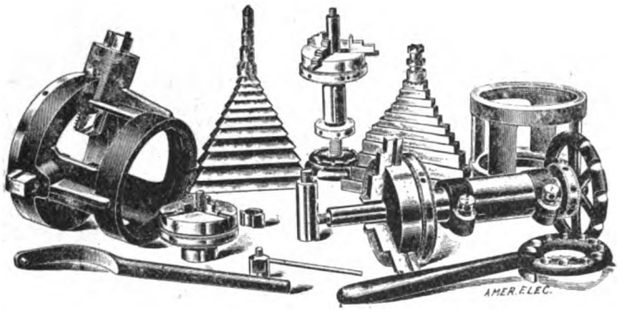



FIG. 7.—IMPROVED MORSE VALVE RESEATING OUTFIT.

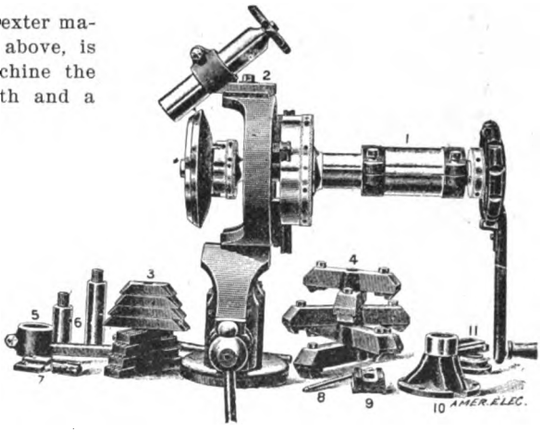



FIG. 8.—DEXTER'S DISC CUTTER.

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## A SIMPLE COAL HANDLING EQUIPMENT.

BY JAMES F. HOBART.

A coal handling machine which is in operation on South Street, New York City, a short distance north of Fulton Ferry, seems to contain several points of considerable value to power station managers. This device is a self-contained power hoist, yet it is portable and easily managed. One man can run the hoisting engine and attend to the crane when a boat is nearly empty. Then it is quicker to shovel up by hand the few lumps of coal that remain, although they can be almost all picked up by the big shovel if the operator is satisfied with the few lumps of coal at a time which chance to be immediately under the shovel when it strikes the bottom planking.

Fig. 2 shows the shovel filled with coal. It has closed and is ready to be hoisted. An old sail is shown in the foreground which is stretched between the boat hatchway and the dock, to catch any pieces of coal which may chance to fall out of the shovel.

Fig. 3 shows the whole machine, the hoisting engine being enclosed in a house which is mounted on wheels, although in this case it has been raised considerably by blocking under the wheels. This, however, is unnecessary if the pile of screenings be kept well cleaned away, so that a wagon body can go under the screen without trouble. The shovel is shown filled and in the act of being hoisted, and when it reaches the boom, or yard, the latter swings up to a vertical position, being pivoted at the bottom for that purpose.

The action of the boom is thus entirely automatic. When fully raised it inclines a very little from the vertical, just enough in fact so that it will be sure to fall when the hoisting chains are slacked off on the drum. That portion of the truck frame which lies forward of the boiler is planked up in the form of a hopper, which will hold about eight or ten tons of coal. At the bottom of the hopper a sliding door is arranged through which coal may be drawn directly into a cart, or into an elevator or conveyor, as may be necessary. When used by a coal dealer and several kinds of coal are to be handled, it is necessary to have several chutes, as shown on the ground in the foreground. These chutes are detachable and are readily removed. The bottom of the chute is covered with wire netting, different sizes of mesh being used to screen out the fine coal and dirt, a pile of which is shown on the ground.

Fig. 4 shows the completion of handling a shovel full of coal, the load having

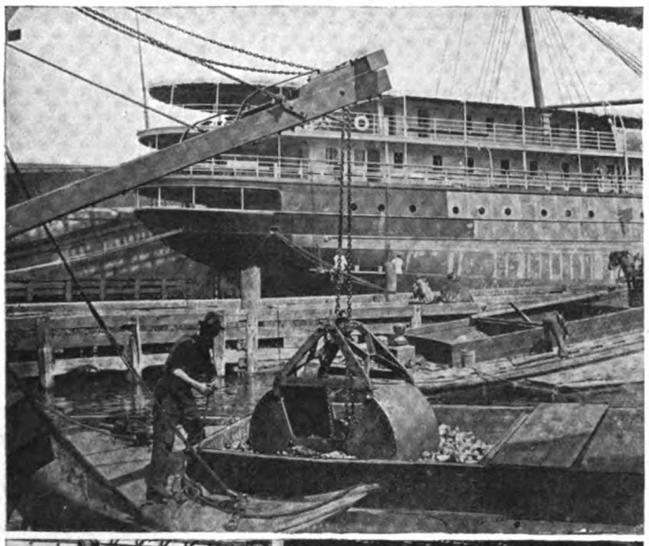


FIG. 1.—FILLING THE SHOVEL.

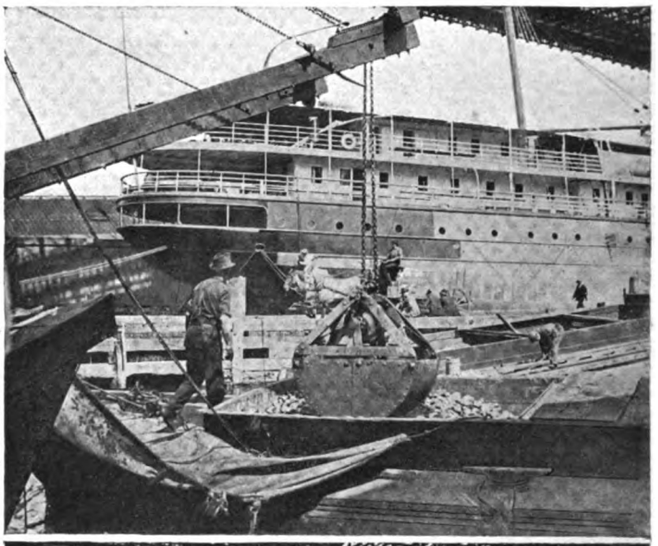


FIG. 2.—SHOVEL SELF-FILLED.

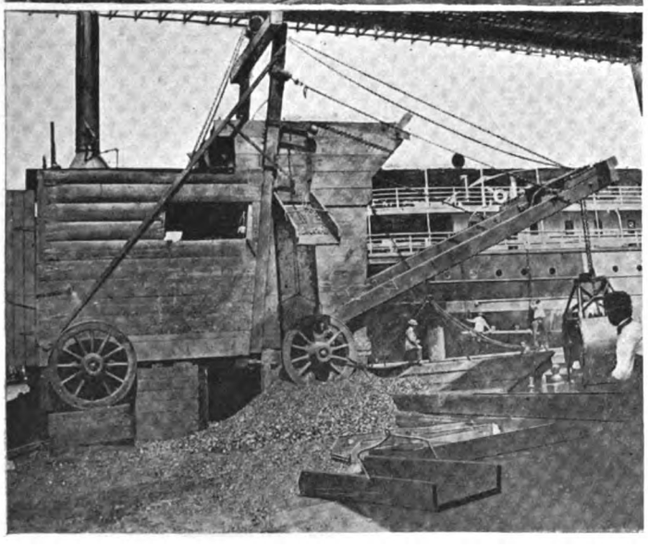


FIG. 3.—HOISTING A SHOVEL FULL.



FIG. 4.—DUMPING SHOVEL INTO CART.

manipulation, which is almost automatic in its action, there being but two chains to pull, the boom or yard taking care of itself. But one other man besides the engineer is necessary, and he attends to placing the shovel in the canal boat, seeing that the shovel, which is self-loading, and is shown in the act of filling in Fig. 1, does not get cramped against the side of the canal boat or jammed against a vessel's bulkhead or side.

There is nothing novel about the shovel. It is of the self-filling variety and nothing need be done to it except

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been dropped into the chute, and being shown in the engraving in the act of running through the screen chute into a cart, to be teamed away.

Once the bucket and boom have been hoisted to the end of their travel, it is only necessary to let go the loading chain and the shovel spills its contents without further manipulation. There is a cart loading chute on both sides of the hopper, and the engraving shows another team on that side also. A complete cycle of operations can be gone through with in about 45 seconds, although 60 or even more can be spent to advantage when there is no great occasion for the highest working capacity.

As stated, this rig, or a modification of it, would prove of considerable value in central station or power house work, and a machine of this kind could be advantageously built upon a car body and fitted with a pair of motors in place of the steam engine here employed. Not only would this arrangement be valuable for handling coal, but it would do great work with ashes, or in ordinary excavating, between or alongside street railway tracks. In such cases the earth could be loaded directly into carts or chuted into cars placed upon the other track alongside. If desired, the boom could be fitted to swing, thereby uniting the virtues of a coal hoisting machine, a steam shovel and a dredging machine.

## A PERMEAMETER FOR SHOP SERVICE.

BY CECIL P. POOLE.

The accompanying sketch shows roughly a design for a permeability testing machine which was built by the writer several years ago and was found to be thoroughly satisfactory under conditions of shop practice where the more delicate appliances commonly used for testing iron were absolutely unreliable because of disturbing influence. The machine is, broadly, a dynamo having for its magnet core the piece of iron to be tested; the pole-pieces and armature core are relatively massive, and the winding, of course, is calculated to give convenient ratios between exciting current and magnetic flux.

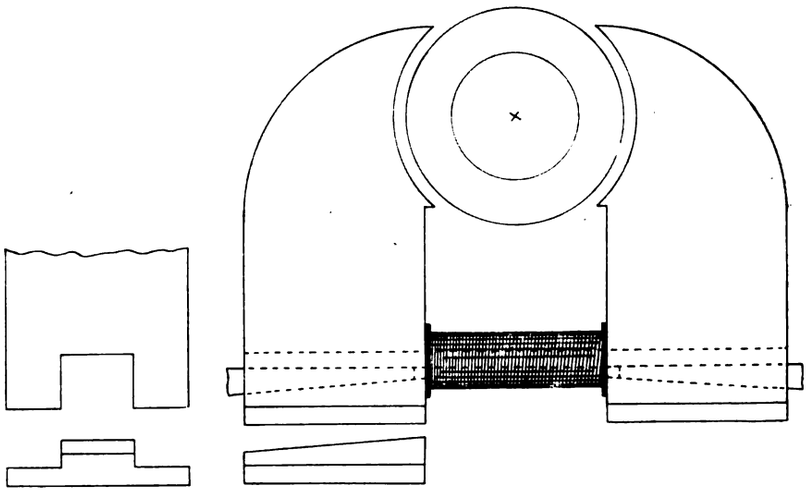
The pole-pieces were 5 inches square. with the edges rounded off to ½-inch radius; the cross-section was maintained unchanged up to the air-gap. The bottom of each pole-piece or yoke was slotted, the slot being 2 inches wide and 1½ inches deep; a foot-piece was provided for each yoke, having a central rib fitting snugly in the slot and tapering from ⅜-inch high at one end to ¾-inch at the other, as shown at the left of the sketch, giving the slot in the yoke an inclined floor. The yokes were bolted to a heavy wooden base, the bolts passing through the foot-pieces just described, so as to make their position relative to the yokes permanent.

The test piece was 2 inches wide, fitting within the yoke slots snugly; 27/64-inch thick and 15 inches long. The distance between the sides of the yokes was 5 inches, and the exciting coil was 4 15/16 inches long over the heads, so as to be easily removable. The test piece was clamped firmly against the surfaces of the yokes forming the upper wall of the slots by means of wedges driven in at each end, as indicated by dotted lines; these did not need to be driven hard home by any means, a couple of light taps with a machinst's hammer, after being pushed in as far as possible by hand, being sufficient.

The armature core was 6 inches in diameter and the radial depth was 1¼ inches; the net axial length was 4 inches, giving a cross-section of 10 square inches. Fibre end rings were used to fill out the length of armature necessary to put the clamping rings (of composition metal) beyond the reach of the field, and the armature was wound, ring fashion, with three layers of No. 13 wire, 375 turns per layer, giving a total of 1125 turns. The direct-reading. An ordinary Weston voltmeter was used, having a range of 150 volts, but it would have been more convenient, obviously, to use an instrument of lower range with a wider scale.

The armature was driven by a small plating machine used as a motor and supplied from two storage cells, a liquid rheostat being used in series with the armature for regulation as the e. m. f. of the cells became lower; the speed was carefully taken four or five times for each test, with a portable tachometer, and the value ascertained originally to be the proper one was, of course, secured before testing.

The machine was calibrated, so to speak, by using a "standard" piece of wrought iron, the permeability curve of which had been previously determined by several ballistic galvanometer tests, and, although this piece was religiously preserved and the machine frequently tested with it, it was never found to vary from the results originally obtained.



PARTS OF A PERMEAMETER.

length of each air gap was ¼ inch; the core was smooth.

The exciting coil was 4⅝ inches long, net, and wound on a bobbin of very thin brass, the interior of which measured 2 1/16 inches by 15/32 inch, the clearance being just enough to permit it to slip over the test piece readily. The coil consisted of No. 12 wire wound in two layers of 50 turns each, so that each ampere of exciting current gave 100 ampere-turns. This coil was excited from a storage cell capable of a discharge rate of 30 amperes, less than 2 volts being required at the highest magnetic densities. The magnetic circuit (beyond the test piece) required 50 ampere turns per 1000 gausses density in the test piece, so that it was a simple matter to deduct from the total exciting force (in ampere-turns) that portion used elsewhere than in the specimen. The speed of the armature was 1017 revolutions per minute, at which speed a voltmeter connected to the brushes indicated 1 volt for each 1000 gausses in the test piece, making the apparatus practically

The reason for using a test piece of rectangular cross-section and lapping the ends was that the machine could be used for testing sheet iron, the sheet being cut into strips of the proper length and width and enough of them bundled together to make the requisite thickness. For testing solid metal only it would have been more desirable to make the test bar round and only 5 inches long (or 4 31/32, to slip easily between the yokes). Firm contact at the ends could have been secured by means of a tightly fitting plug, screwed through one yoke so as to butt against the end of the test piece. Then the exciting force could be expressed in ampere-turns per inch of length, whereas with the rectangular test piece the permeability curve had to be plotted first, the abcissae being in ampere-turns instead of in terms of H. It was intended originally to thus build the machine, but the more universal character obtained by making the test piece rectangular outweighed the greater convenience incidental to the other construction.

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## A SMALL STORAGE BATTERY PLANT FOR DOCTORS.

BY F. E. WOODFORD.

As the use of storage batteries for large power houses and sub-stations is continually increasing, their adaptibility for almost every kind of work is becoming more and more realized. With their increased demand, a corresponding increase in their quality has been the result, until at present, with their high efficiency and the flexibility with which they can be operated, their use as small auxiliaries of electric power has gone far past the experimental stage. But while portable storage batteries for the use of physicians have been on the market for a long time, it is only lately that doctors are having complete storage battery plants installed in conection with their offices to operate such devices as may there be used. It is not every locality or condition that will warrant its use, but in a great many cases, as with the one in question, it will prove very satisfactory and convenient. As nearly every case has its peculiar requirements, which are different in detail, I will not try to describe such an installation in a general way, but take up the details of an individual case.

In small towns, where the central lighting plant is run only at night, and in some places where this is even limited to part of the night, the physician who wishes to keep up with the times and whose success depends partly on the use of modern methods and appliances, is handicapped in a great degree. If he has an examination of the ear, throat or nose to make, he must use a kerosene lamp and intensifyer or make an appointment for evening, in order to have the benefit of the electrical appliances for such purposes. Delicate operations of the throat and nose can only be performed to advantage in the evening in such places. He has to use a battery which is expensive and cumbersome to heat his cautery knives, and is compelled to do many things by old methods, which, if electricity were available at any time during the day, could be accomplished in a much more successful manner. Nor is this the limit of his troubles. If the door bell rings and he is called at 2 o'clock in the morning, he arises to find he cannot turn on a light or that the light is unusually dazzling from an extremely high voltage, the outcome of a nap on the part of the attendant at the lighting station.

In some towns the lighting plant is shut down at midnight or 2 o'clock every morning. Such is the case with the physician who has made use of the storage battery plant under consideration. His house and office are supplied with electricity from dark until 2 o'clock A. M., a time which it might almost be said in his profession he needed it least. After making a thorough canvas of the appliances he wished to operate and the results he wished to obtain, it was decided that a small storage battery plant for this particular case was the most desirable.

Very good lamps can be obtained on the market that will give from sixteen to twenty candle-power at 30 to 38 volts. As these lamps, which are placed in the office, sleeping apartment and on the porch, are the appliances requiring the highest voltage, this determined the number of cells required. Sixteen cells were accordingly selected and arranged to be connected in series direct to these lamps when otherwise not in use.

As the heating of the cautery instruments requires the greatest amount of current in the list of physicians' instruments, it is the current used here that determined the size of each cell. The size of each cell is such that eight of them will heat the heaviest cautery knife, leaving the other eight to operate such instruments as might be in use at the same time. Each cell is capable of discharging eight amperes, consequently this battery of eight cells connected in multiple series, two in each series, will discharge 32 amperes at four volts, and for a short period of time still more current without injury.

The connections of the apparatus are shown in Fig. 1. With the switches open, as shown, the battery is connected direct to the lamps in office, bedrooms and on the porch. Everything in connection with the battery and medical apparatus is operated from the cabinet switchboard, which is placed in the office and as near to the batteries as was possible, to save wiring. The battery is charged by closing the switch at the top of the figure, which connects it through the resistance, R, to the 110-volt lighting circuit. The resistance coil, R, is made to carry the same amperage as one of the lamps, to prevent the lamp from burning out should it be turned on during the time of charging. In case two or more lamps are turned on at such a time, the battery will discharge into the line, thus keeping them to their full brilliancy. When the switch is closed to charge the batteries, it also cuts off all the medical apparatus at the switchboard, thus preventing its being damaged by the 110-volt current.

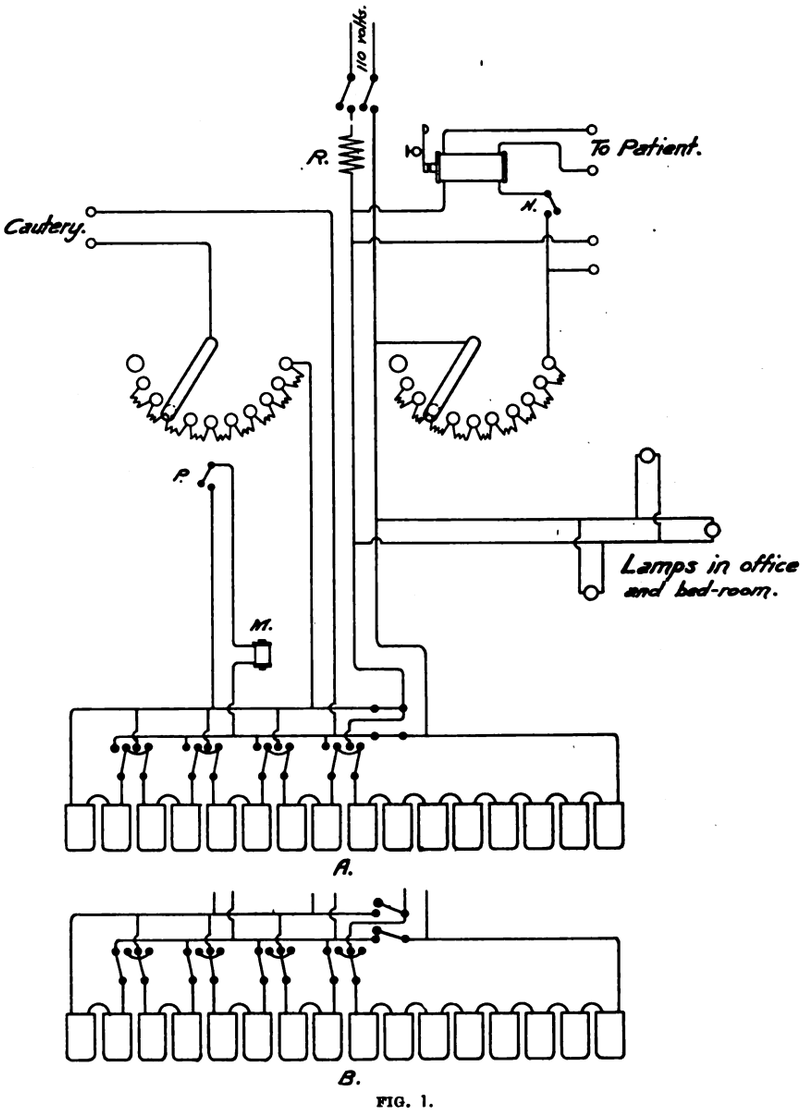



FIG. 1.

The cell being appreciably large for the small amount of current it has to furnish for the lamps, has its advantage in this direction, as well as for use with other

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appliances, as it is discharging below its normal rate, which lengthens the life of the cell, and its charging is consequently less frequent. And while its size must be such as will meet the demands upon it by the cautery instruments, the current thus used is for such a short period of time that this discharge is ineffective upon its capacity. It has, therefore, been found that while the size of these cells is barely sufficient to meet their heaviest requirements, their use in the doctor's office is very successful and practical.

When the instruments connected to the switchboard are in use the battery is placed in connection, as shown at B, Fig. 1. The eight cells on the left supply current for the cautery knife alone. The cautery terminals, together with its rheostat, are shown on the left. The rheostat has 32 steps graduated to control the current from zero to five volts, making it possible for a variety of instruments to be heated from these terminals.

The eight cells on the right are left in

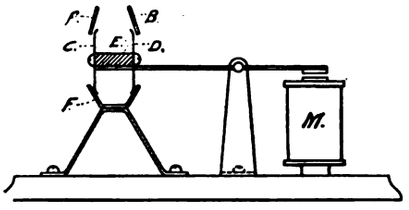



FIG. 2.

series, as shown, their current being conducted through the rheostat shown on the right to the lower pair of terminals. From these terminals can be operated a physicians' mouth lamp of one-half candle-power, also a head lamp of fourteen candle-power, and other lamps of the miniature type used in examinations and operations. This rheostat has a wide range of resistance and is also adapted to graduate the pressure of the current delivered to the induction coil from zero to sixteen volts. This induction coil is shown above and to the right in the figure. The secondary leads are conducted to the patient through the upper pair of terminals. These instruments are always operated from the eight cells to the right, and when the battery is connected, as shown at B. Their operation is, therefore, never affected by the cautery current.

The changing of the battery connections from A to B is accomplished with the apparatus shown in Fig. 2. A and B are sections of the conductors whose terminals lead up to the cautery side of the switchboard. Immediately under these copper strips, which form the main conductors, are five pairs of brass springs, C and D, screwed to the fibre strip, E. These brass springs are connected to the terminals of each series of two cells and each forms the arm of a switch. By their own weight they make a contact with the copper strips, F, which are four in number, thus connecting the whole battery in series. By closing the switch, P (Fig. 1), the magnet, M, is supplied with current at 32 volts. The magnet consequently gives a strong pull, raising the springs, C and D, which press against the conductors, A and B, thus putting the battery in the connection shown at B, Fig. 1. The magnet of the apparatus is now supplied with current at four volts, which is sufficient to hold the springs in a good contact with the conductors until the switch, P, is opened, when they will be released by the magnet and again drop, putting the battery in series. The fifth pair of springs, C and D, by this same action throw the battery into the two sections of eight cells each.

## Letters on Practical Subjects

### The Corrosion of the Leading-In Wires of Incandescent Lamps.

*To the Editor of American Electrician:*

Sir—A short time ago I installed a small electric light plant in a plating shop to the entire satisfaction of the owner, but lately the incandescent lamps gave trouble. Frequently one or two lamps would go out and not one of the filaments was broken. I was finally called in to inspect the plant.

After careful tests and finding all fixtures and wiring O. K., I naturally turned to the lamps, and although the filaments were intact, every lamp was open. Upon smashing one of the lamps I found that considerable moisture and fumes from the plating baths had gathered in the hollow base of the lamp and had partly filled the inner tube of the lamp just above the seal of the platinum wires.

This of course formed an excellent plating bath on a small scale and electrolysis soon ate the positive wire clean through. I did not anticipate that so much acid could be deposited in the base of a lamp, but this shows the importance of selecting a lamp with a solid base wherever fumes are present. I would also suggest that the plaster in the base be thoroughly varnished with shellac, to prevent absorption.

E. C. MEILLORET.

Ozone Park, L. I., N. Y.

### Electrically Illuminated Tower Clocks.

*To the Editor of American Electrician:*

Sir—The subject of clocks is always an interesting one to me and illuminated tower clocks more so. I have noticed recent patents on the latter and wish to say that I experimented in that line some twenty years ago. My plan accomplishes three things. It does away with ground glass dials, which are expensive. It does away with inside lighting. It enables the time to be told at a much greater distance. I use but three lights on each dial, a red one on the end of the minute hand, a green one on the hour hand and a white frosted or a yellow one on the center post. No effort is made to light up the figures on the dial; the time is told by the position of the red and green lights on the hands as they revolve around the white one on the center post, just as blind man can tell the time by feeling the hands of a watch. I used a five-foot dial and had a number of assistants, mostly boys, strung out in a line for half a mile and could tell the time within a minute or two at 2,400 feet. The lights were changed by an assistant at random a number of times, all of us keeping a record, the boys singing out the time instantly.

The lamps may also be rigged out on light extension pieces, so as to double the length of the hands, making the dial appear twice as large and, of course, increasing the distance at which it may be seen. I took no patent on this, but give it to the world for what it may be worth

EDWARD ROWE.

Indiana, Pa.

### Smoke Consumption and Economy of Fuel.

*To the Editor of American Electrician:*

Sir—I have recently seen the "Advance Sheets" of some consular reports dated May 20th, 1899, and the first article is headed "Smoke Consumption and Economy of Fuel," in which Consul General Mason of Berlin, Germany, tells about what he evidently thinks is a new and important system, although it consists simply of hollow grate bars carrying to the fire a hot air blast. If Mr. Mason knew what an egregious ass he made of himself in that article, in the eyes of all who are posted on boiler furnace systems, he would avoid hereafter being quite so ready a tool of those who give a new name to an old method and then by the use of the names and influence of men of position seek to fool someone into buying a patent which is not worth the paper it is written on.

That so-called "new system" of Mr. Paul Cornelius is in fact a very old system, and, in the nature of the case, not at all satisfactory as a smoke preventing system, or desirable from the economical standpoint in burning bituminous coal of any grade.

The spectacle of one of the Consul Generals of the United States looking at such an apparatus and gravely recording in a "Report" its freedom from smoke when burning "Coke Dust," makes it very clear that Mr. Mason's anxiety to serve his countryman has been taken advantage of by a shrewd "promoter," who seeks to catch the gullible capitalist.

If they succeed in getting the government of Sweden to pay any considerable sum for what Mr. Mason styles, in parrot-like form, the "Swedish patents," that will be a double-header sale, for both the patent and the people of Sweden will be sold.

A. L. HARRISON.

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# Electrical Catechism

*332. How much is the pull on a single wire carrying current through a magnetic field?*

The pull (measured in dynes) is found to be equal to the product of the strength of the field (measured in lines of force per square centimeter) by the strength of the current (measured in the C. G. S. unit, which equals ten amperes) and by the length of the wire (in centimeters) which is in the magnetic field. Using grammes, centimeters and amperes, the pull in grammes equals the product of the amperes by the number of lines of force per square centimenter by the number of centimeters length of wire in the field and divided by 9,810. Using English measures, the pull in pounds equals the number of lines of force per square inch multiplied by the number of inches of wire in the magnetic field multiplied by the number of amperes through the wire and divided by 11,303,000.

*333. How much is the pull on the whole surface of an armature of a motor?*

If the magnetic field is assumed to be of uniform density, we may calculate the pull on each wire as above and multiply by the number of wires on the armature, remembering that the current in each wire is only half the whole current through the armature of a two-pole machine, and considering as the length of each wire only that part that is on the cylindrical surface, neglecting that on the ends. An easier method is to consider the number of lines of force through the armature. The number of dynes pull on the surface, measuring in C. G. S. units, equals the product of the number of lines of force through the armature by the number of wires and by the current divided by the circumference of the armature. The pull measured in grammes equals the product of lines of force by amperes by number of wires divided by the circumference, multiplied by 9810. The pull in pounds equals the number of wires by the current by the lines of force divided by 35,525,000 times the diameter in inches.

*334. Give an example of calculating the pull on an armature.*

Take the case of an Edison bipolar motor taking 80 amperes at 117 volts running at 1400 revolutions per minute, having 200 armature wires and 2,500,000 lines of force through the armature, which is 6½ in. in diameter. The pull on the surface is then

$$P = \frac{200 \times 80 \times 2\,500{,}000}{3.14 \times 6.5 \times 35{,}525{,}000} = 200 \text{ pounds.}$$

*335. What is meant by torque?*

By torque is meant the pull at unit radius. In metric system it means the number of dynes pull at a distance of one centimeter from the center or the number of grammes pull. In English measures it means the number of pounds pull at a radius of 1 in. or of 1 ft. Torque is measured in dyne-centimeters, gram-centimeters, pound-inches or pound-feet. In the case of street railway motors it is common to speak of the torque exerted on the circumference of a wheel 33 in. in diameter.

*336. How is the torque calculated?*

The torque in pound-feet equals the product of armature wires by amperes by lines of force divided by 852,500,000. For example, the torque in pound-feet of the above machine is

$$T = \frac{200 \times 80 \times 2{,}500{,}000}{853{,}500{,}000} = 48 \text{ pound feet.}$$

*337. Can the torque be calculated from the power taken by the motor?*

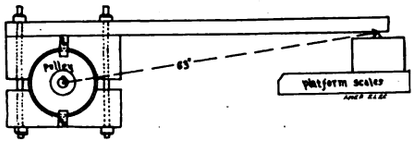
It can, roughly. The above machine takes 80 amperes at 117 volts, or 9,360 watts, which, divided by 746, is 12.55 horse-power; this multiplied by 33,000 gives 414,150 foot-pounds as the energy taken by the motor and given out by it if there were no losses in the motor. Since it makes 1400 revolutions per minute, the velocity at a radius of 1 ft. is 6.28 times 1400, or 8792 ft. per minute. Dividing the 4.4,130 foot-pounds by this velocity gives 47.1 as the pull at the radius of 1 ft. This agrees closely with the 48 pound-feet of the previous calculation.

*338. How can the torque of a motor be actually measured?*

The easiest way is to stop the motor, remove the belt, attach a spring balance to the pulley in such a way as to measure the pull at its periphery. Then, using a rheostat to control the current, send as much current through the armature as is taken in regular working, and measure the pull on the spring. Another way is to clamp a piece of wood to the pulley and arrange a platform scales so as to measure the downward thrust when the motor attempts to start; the scales then weigh the pull at a radius equal to the distance from the center of the shaft to the point where the lever touches the platform. There are several forms of transmission-dynamometer for measuring the amount of power developed by actually weighing the difference between the pull on the tight and on the loose sides of the belt.

*339. How can the power of a motor be measured?*

A prony brake is the most convenient method for general use. A simple form




A SIMPLE FORM OF PRONY BRAKE.

suitable for short tests consists of two blocks curved to fit the pulley and having a long arm and two bolts, as suggested in the figure, and two guide pieces on each side to keep it from slipping off sidewise. The end of the arm rests upon a sharp edge, which is supported upon the platform of a scales. The scales measure the torque at a radius equal to the distance from the center of the shaft to the knife-edge. If in a given case the pressure is 5 lbs. at the distance of 63 in., the torque is 315 pound-inches, or 26.25 pound-feet.

*340. Can the work done by a motor be measured by such a device?*

It is only necessary to let the motor run and then measure the pressure on the scales and also measure the speed. The work equals the product of the torque by the velocity at that radius. The calculations are simplified if the distance is 63 in., for then the circumference of the circle passing through the knife-edge is 33 ft., so that 1 lb. pressure at 1 000 revolutions per minute would mean 33,000 foot-pounds, or 1 horse-power. In such a measurement it is desirable to lubricate the blocks by soapy water or by a ham-rind, to prevent jerky action.

*341. Give an example of a test on a prony brake.*

Suppose the arm is 63 in. long, the pressure is 8 lbs. and the speed is 1400 revolutions per minute. Then the point at the knife-edge would travel 33 ft. in each revolution, which at 1 400 per minute would be 33x1 400, or 46,200 ft., per minute. Now, multiplying this by 8 gives 369,600 foot-pounds work done per minute. But 33,000 foot-pounds make one horse-power, hence dividing by 33,000 gives 11.2 as the horse-power.

*342. How can the efficiency of a motor be determined?*

Connect an ammeter in series with the motor and a voltmeter across its terminals, so as to measure the electrical energy supplied. Measure the mechanical work given out by the prony brake. Reduce both to horse-power or watts and divide the work given out by that absorbed.

*343. Give an example of measuring efficiency.*

Suppose the motor measured in No. 340 takes 84 amperes at 117 volts. The electrical energy taken is then 84x117, or 9828 watts, or 13.2 horse-power. Dividing that delivered by that received gives 11.2÷13.2=0.85, or 85 per cent., as the commercial efficiency of the motor at that load.

*344. How can the efficiency at different loads be determined?*

By clamping the two blocks together more or less tightly, the load may be varied, and so the electrical and mechanical power may be measured for different loads.

*345. How can one tell how much power a motor is giving out when it is in regular service driving machinery?*

If the motor can be cut loose from the regular load and a brake applied, the efficiency may be determined for different currents as above indicated. Then by measuring the current and voltage while it is working at its regular load and multiplying by the efficiency of the motor for such load, we can determine the power being delivered.

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# Queries and Answers

Readers of the American Electrician desiring answers to inquiries through this department are requested in every case to give their full names and Post Office addresses. The number of inquiries is so great each month that complete answers to all would fill many pages of the American Electrician. A large number of these inquiries, such, for example, as requests for the size of wire for a given motor, are not points of general interest; others necessitate a request for further data before they can be answered; still others are so general in character that they can only be answered by the reading of a book. The publication of all these queries and answers would fill these pages with much matter of no value to the general reader. All questions will be, so far as possible, answered by mail, and only those bringing out valuable points, sufficient in number and length to fill this page will be published. Readers who do not receive a response to their queries may attribute it to their failure to give a proper mailing address.

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In the experiment of heating an iron rod in a bucket of water by electricity, to a red or melting heat, what salt is added to the water? Does this act chemically, or is it just to increase the conductivity of the water? E. T.

Ordinary common salt or sulphuric acid may be used. The action is not chemical, the purpose of the salt being simply to reduce the resistance.

Do you have to use two pairs of lamps with each pair in series and two grounds for a ground detector on the three-wire system? E. H. S.

No. Use 4 lamps in series with one ground between the two middle lamps and connect one of the outside lamps to the positive and the other to the negative main.

(1) Can an ammeter with a range of from zero to 10 amperes be used on a primary circuit of 1000 volts and read accurately?

(2) If you cut a voltmeter in a circuit ahead of the ammeter, will you get the current through the voltmeter and will it have any effect upon the reading of the voltmeter and vice versa?

(3) How can I find the current that a motor takes, horse power, voltage and speed being given? A. C. R.

(1) Yes, if it is built for alternating current. (2) The ammeter will not indicate the current going through the voltmeter, but the latter is, as a rule, negligible, owing to its small amount. The ammeter will have no effect upon the reading of the voltmeter, nor vice versa. (3) Multiply the horse-power by 800 and divide by the voltage.

Will you give the rules in designing transformers for the size and amount of wire? I have a number of old transformers to rewind and wish to change the secondary voltage from 52 to 104 and from 52-104 to 104-208. What is the effect of using transformers wound for 125 cycles on 60 cycles? Can you give me the name of a book covering the above in a practical manner? E. L. E.

To double the voltage of the low tension side of transformers the number of turns in the secondary should be doubled. The cross-section of the wire will then have to be reduced at least 50 per cent., which is 3 numbers on the Brown and Sharpe gage, and as a rule somewhat more, owing to the greater amount of insulating material. Thus, if the original size of wire in the secondary is No. 8, to get double the voltage it will have to be rewound with practically No. 12 wire, using twice as many turns. Transformers built for 125 cycles can be used on 60 cycles. See the American Electrician, May, 1899, page 225. A good book on transformer design is "Haskin's Transformers, their Theory, Construction and Application." Price $1.25.

Suppose I had a switchboard containing several circuits and that I found I had a heavy ground or short circuit, what would be the best way to determine on what circuit or where the ground is? Assuming I had ground lamps on switchboard and also not having them. Should I first try the generator for a ground, and not finding it on the machine, should I then try each circuit separately with galvanometer or voltmeter? By trying each circuit separately and having ground lamps, could I tell it on the ground lamps? J. B. F.

If each circuit is separately fused the location of a short circuit can be determined by the fuses which blow. In case of a ground proceed, as you have indicated, trying the ground lamps first with the machine alone in circuit and then adding the various feeders until the ground is indicated. In case you have no ground lamps on the board you can temporarily rig up a pair connected in series across the mains with their center connected to ground, or you can use a voltmeter, connecting one of its terminals to the ground and connecting the other terminal first to the positive main and then to the negative. If the voltmeter shows no voltage on either line there is no ground. If it shows full voltage when connected to the positive line the negative is grounded and if it shows full voltage when connected to the negative line the positive is grounded.

I have a small wheel-break interrupter run by a motor to connect with the primary of a 1-in. spark induction coil. It is 3 in. in diameter and is made to give 50 interruptions per revolution. No insulation is used except air insulation between the breaks. One of the terminals connects with the shaft, the other with a copper strip pressing on the wheel. Now, with the common vibrator interrupter I can get the longest spark, while with the wheel I only succeed in getting a much smaller one in spite of more pressure in the primary and increased interruptions. In fact, I can place my hand on the secondary terminals without much pain. Can you tell me what the trouble is? E. H.

The trouble is undoubtedly due in large part to the increased rate of interruptions. The current does not get time to get well started in the coil each time the circuit is made before it is again interrupted. The counter electromotive force of self-induction chokes back the current when the circuit is first made, and it takes perhaps one-tenth of a second for the current to reach approximately its full strength. You do not state the speed of your wheel, but if it gives 50 interruptions per revolution and runs at 300 r. p. m. it will give 250 breaks per second. If the make is the same length as the break the current will only have 1/500th part of a second to build itself up in the coil, which is altogether too short a time. The wheel should be run at a very low speed. Its contacts should also be shunted by a condenser, just as is the ordinary vibrator.

I have a small motor used to run on 110 volt circuits. The fields are shunt wound and the armature is a smooth drum core with 12 sections. I wish to make it run on alternating current. Would I be able to do so by having two collector rings attached to opposite sections of the commutator; would it be self-starting, and would it still run on direct current without disconnecting rings? M. N.

Your motor will work as a synchronous machine on alternating current circuits if you can run it up to the proper speed. Assuming that it is a bipolar motor, its speed must be 3600 r. p. m. for 60 cycle current and 8000 r. p. m. for 133 cycle current. It would still run on direct current without disconnecting the rings and would serve also as a rotary converter to change direct into alternating current, or vice versa. Its alternating voltage would be about 78 volts. It would not be self-starting and would have to be started by direct current or by external mechanical means. If it cannot be run at this high speed, there is no practical means of making it operative on alternating current unless it has a laminated field, in which case it can be rewound as a series motor and used with a. c. supply, but will only give an output considerably less than that as a direct current motor.

(1) How can I test the core loss in transformers?

(2) On what does the voltage, amperage and light giving power of incandescent lamps depend?

(3) What are arc light carbons made of?

(4) In what way do series incandescent lamps differ from those intended for parallel use?

(5) In electrical work, what is the use of a condenser? V. M.

(1) Obtain an alternating current wattmeter capable of measuring the core loss, which is about 3 to 5 per cent. of the rated capacity of the transformer, i. e. for a 20-light or 1 kw. transformer the core loss will be about 30 to 50 watts. The core loss can be measured on the secondary circuit, the primary being disconnected. (2) Upon the cross section, length and specific resistance of the filament. (3) See "American Electrician," June, 1899, page 295. (4) Series incandescent lamps have filaments much thicker, shorter and of a great deal lower resistance than multiple lamps, as they are designed to work on lower voltages, generally only 20 to 30 volts. They could be worked in parallel on these low pressures if it were desirable. (5) Condensers are used sometimes on alternating current circuits to compensate for lagging currents. In telephony they are quite generally used to let pass alternating, but choke back direct currents, and in telegraphy they are used to balance duplex systems for line capacity.

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## THE MERSHON COMPENSATOR.

Many central station engineers, who are familiar with or even use the Mershon compensator for obtaining correct voltmeter indications on alternating current circuits, find it difficult to understand thoroughly how the instrument works or why it gives such correct results on loads of any magnitude or any power factor, doing away entirely with the need of pilot wires. The writer thought he knew

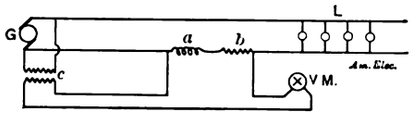



FIG. 1.—SIMPLE CIRCUIT WITH NO SERIES TRANSFORMER.

its principle, but when asked recently about it found he could not explain it properly and improved the opportunity to look up the patents, No. 551,982 and No. 571,839, issued to Mr. Ralph D. Mershon, covering the principle of this ingenious device. An explanation of the instrument in its two most simple forms may be given in untechnical language as follows:

Referring to the diagram shown in Fig. 1, G is the generator supplying a load, L, which may consist of motors or arc or

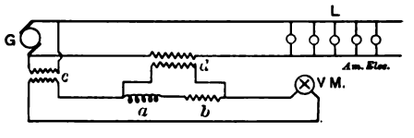



FIG. 2.—CIRCUIT WITH SERIES TRANSFORMER

incandescent lamps supplied through transformers. c is the instrument transformer designed to supply only the voltmeter, VM, and the purpose of the compensator is to make the voltmeter indication proportional to the pressure at the load center instead of at the generating station. In order to do this the compensator must subtract from the pressure upon the transformer, c, a certain amount proportional to both the ohmic and inductive drop in the lines and in step therewith, and this must be done whether the current in the lines is in step

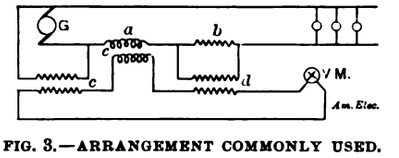



FIG. 3.—ARRANGEMENT COMMONLY USED.

with the electromotive force, lagging behind it or leading ahead of it. The arrangement indicated in the upper diagram is very simple.

Assuming that the machine is a 2000-volt generator and the transformer, c, has a ratio of 20 to 1, the normal scale reading of the voltmeter being 100 volts, then the proper drop is introduced by inserting at b an artificial resistance equal to 1/20 the total resistance of the line or feeder and at a an artificial inductance equal to 1/20 the total inductance of the line or feeder. The circuit from the instrument transformer, c, to the voltmeter, VM, is passed through this resistance and inductance. When there is no load upon the line the small current given to the voltmeter will occasion no perceptible drop in this resistance and inductance, but as the main line load rises 1/20 of the main line drop occurs in this resistance and inductance and is subtracted from the voltage of the secondary of the instrument transformer, c. Thus, if the generator pressure is 2000 volts and the drop 100 volts, the drop in a and b will be 5 volts, which will be subtracted from 100 volts at c, giving the voltmeter 95 volts, exactly equal to what would be impressed upon lamps connected to a 20 to 1 transformer at L. It will be noticed that if the current in the main line lags behind the impressed electromotive force, thus increasing the reactive drop, it will do the same in a and b, increasing the effective drop in the path of the voltmeter.

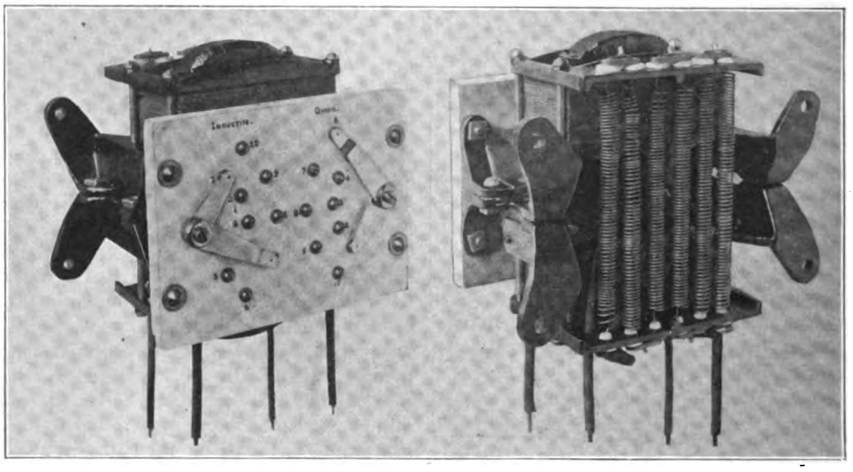


FIG. 4.—FRONT AND REAR VIEWS OF THE SERIES TRANSFORMERS, OHMIC AND INDUCTIVE COILS AND ADJUSTING DEVICES AS ARRANGED FOR SWITCHBOARD USE.

The diagram Fig. 2 gives the circuits as they would be when a series transformer is used in the main line to avoid the necessity of connecting the instrument electrically with the high tension circuit. In this case the arrangement is exactly the same except that a and b are supplied with current proportional to and in step with that in the main line by means of the series transformer, d. c is as before, the instrument transformer supplying VM through a and b. The drop in the latter is made proportional to that in the line by means of proper transformer ratios, so that the instrument gives an indication proportional to the voltage at the distant end of the line. In case of a feeder running to one large step-down transformer or even supplying scattered smaller transformers, the inductance and resistance of a and b can be made proportional to both the properties of the line and transformer, so that the drop of both can be compensated for, the instrument giving the pressure upon the secondary system at all times, even with heavy lagging currents.

There are many other possible arrangements of the circuits for accomplishing the same purpose, but of them all the Westinghouse Electric & Manufacturing Company prefers to use commercially that indicated in Fig. 3. Here again, G is the machine supplying the load, L and c is the instrument transformer for the station voltmeter, VM. The inductance, a, and resistance, b, are in this case inserted serially in the high tension circuit and their drop is introduced into the voltmeter circuit by means of two small transformers, e and d. As the inductance, a, is wound on an iron core, this core is used as that of the transformer of which the inductive winding, a, becomes the primary. The primary of d is shunted around the non-inductive resistance, b, its secondary being connected in series with the secondary of the inductive transformer, e, as well as the instrument transformer, c, and the voltmeter. The transformer, e, has an open magnetic circuit to increase the self induction, while d has the usual closed core. In this arrangement c gives to the voltmeter a pressure proportional to that of the generator, while e introduces into the voltmeter circuit a drop proportional to and in step with the inductive drop of the line, and d introduces into the voltmeter circuit an e. m. f. proportional to the ohmic drop in the line. The result is that the voltmeter indicates the pressure at the distant center of distribution.

The resistance and inductance apparatus as made by the Westinghouse Company is shown in Fig. 4. Here the non-inductive resistance consists of helical wire coils of the ordinary form and the two small transformers indicated by the letters d and e in Fig. 3 may be seen on the back of the marble slab. Both the ohmic and inductive drops are made adjustable by the rotatable contacts shown, so that the instrument can be set at any time for the properties of the line to which it is connected.

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## THE SCIENTIFIC TREATMENT OF IMPURE BOILER FEED WATERS.

BY J. H. PARSONS.

The subject outlined above is one of great importance, on account of its perplexity, and hence commands the immediate and careful attention of every steam user. It involves interests sufficiently extensive to give it great importance and demands the utmost exertions of engineers towards the solution of its problems and the provision of remedies to counteract the evil effects of impure boiler feed water. The subject is partly a chemical and partly a mechanical one, and so requires a study from the theoretical as well as the practical side.

Compounds and water purifiers, both chemical and mechanical, frequently fail to work, for several reasons. Often the steam user expects and looks for too much A successful treatment may not be necessarily a complete annihilation of all troubles. No one compound can be made to do work for all waters and it is absurd for any one to offer such a compound for sale. Even were it possible to prepare a standard remedy, the dose and form of application would not suit all cases. Where lime and magnesium exist in the water in the form of carbonates without sodium salts, it would be an easy matter to treat the water successfully with a simple remedy. But suppose the lime to be in the form of a sulphate and the magensium a carbonate, with a large excess of the former, the treatment could not be a success without a more energetic and thorough transformation of the salts. Then again in the presence of chlorides the magnesium salts change to chlorides, which under heat liberate hydrochloric acid and this acts on the metals of the boiler. This condition has to be understood, and we must determine whether it will arise when the special sample of water is heated, before a formula for a good antidote can be devised.

In the case of iron pyrites, sulphate of copper and sulphate of iron in water under heat, free sulphuric acid is often produced in large quantities. After careful laboratory tests we can determine how much of the acid is formed under heat and pressure, how much of the acid will unite with the lime and magnesium contained in the water, and how much will remain as free acid. Different reactions require different remedies. The chemist must use great care in preparing each formula. He must use the results of experience with boilers with his knowledge or chemistry to make the formula a sure, economical and safe one. He must not put into the preparation anything which will of itself decompose into, or form with the salts in the water, a troublesome element.

An analysis of a sample of water may be correct, but if misinterpreted or if the final results which take place in the water under heat and pressure are misunderstood, it becomes a matter of guesswork and the remedy, if made, is not a scientific one, but a conglomeration of half a dozen, often more, ingredients sent out with the hope that some one or two in the lot will hit the nail on the head or do the work required.

It is only by a careful preliminary study of the water used, and by the use of a remedy which will precipitate each of the scale forming salts contained in the water in the form of a non-crystalline or non-adhering mud or silt, at the same time neutralizing the corrosive elements that it is possible to prevent incrustation and corrosion. By this method of treatment the rapid deterioration of the metallic sheets of the fire surfaces of the boiler and the danger of explosion are lessened.

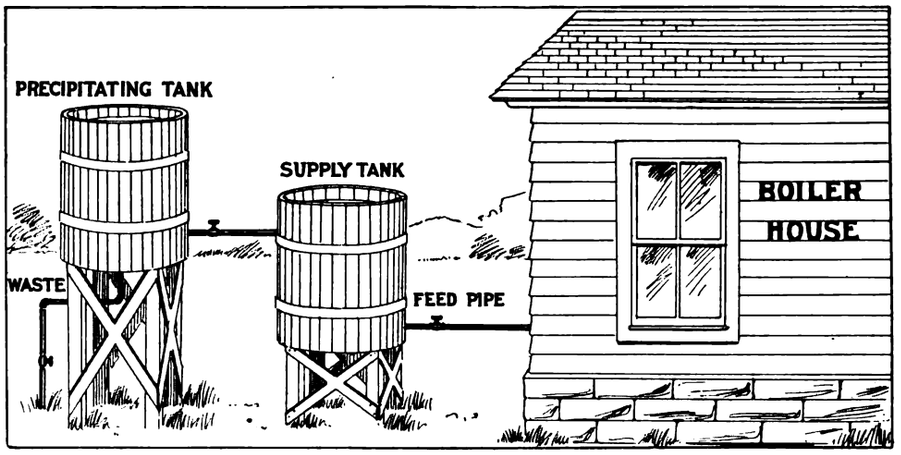



FIG. 3.—ARRANGEMENT OF TANKS AND PIPING FOR FEED-WATER PURIFICATION.



FIG. 1.—SCALE FORMED OF SULPHATE OF LIME.

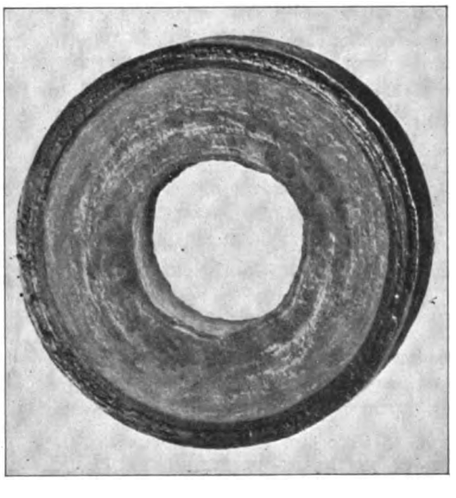


FIG. 2.—A TUBE FILLED WITH CARBONATES.

Fig. 1 shows a scale formation composed largely of sulphate of lime. Fig. 2 shows a scale formed from magnesium carbonate and from magnesium sulphate.

For waters very heavy in salts of lime and magnesium (sulphates and carbonates), silica, iron and salt, the writer would recommend a treatment to secure the precipitation of scale forming silts and neutralizing corrosive elements without the aid of heat, a precipitating tank being used.

When properly treated, generally 85 per cent. (often more) of the scale forming salts can be precipitated and all of the corrosive elements neutralized before the water reaches the boiler. By doing this properly and drawing the precipitate out before feeding to the boilers, the trouble universally experienced when using impure feed water can be prevented.

There should be two tanks, each holding about the day's supply. The water from the first, or precipitating tank, after being treated with our remedies, may be run into the second, or supply tank, and from this fed to the boilers, while the first tank, filled again, is being treated and settled for the next day's supply. The waste pipe with stop valve should be placed in the lower extremity of the tank. One tank will answer if the supply water is drawn from it after the precipitate has had time to settle and has been drawn off. The illustration shows a plant erected by the J. H. Parsons Chemical Company of 1509 Masonic Temple, Chicago, Ill., capable of treating waters from 500 gns. of total solids per gallon down to 25 gns. per gallon, the remedy being made to suit each water after the analysis is made.

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## THE BRUSH MULTI-CIRCUIT ARC DYNAMO.

In the course of the first ten years' development of series arc lighting, the size of generators gradually increased from a few lights up to 65 lights, requiring approximately 3000 volts from the dynamo to operate the circuit. At this point the building of larger arc dynamos was checked for the want of better line insulating materials. These, however, were found by a few electric light companies, and during the years of 1893 and 1894 the Brush Electric Company brought out its 125 light arc dynamo, 6250 volts, 9.6 amperes, 500 r. p. m., known originally as No. 9, and later as No. 11. The companies had much trouble in introducing these machines, due to the poor line insulations upon which many of them were operated, causing many burn-outs and troubles on the circuits. What was desired was a machine on which a larger number of lamps could be operated without increasing the potential in proportion to the number of lamps run. The multi-circuit arc generator filled this want.

The Brush arc generator was particularly well adapted for the multi-circuit system of arc lighting, the armature being constructed in a sense as though it were several separate and distinct armatures or generators, each taking its share of the load, so that they could be readily divided up. In single circuit machines the separate armature divisions are connected directly in series with each other and all the lamps in one series, as shown in Fig. 1, thereby giving the maximum difference of potential across the terminals of the machine, as illustrated in the curve of potential gradients, Fig. 2.

The multi-circuit system, which is covered by patents, consists, broadly speaking, of dividing up the lamp load into several circuits, and interposing the different sources of electromotive force, or the different armature divisions in the Brush arc generator, between the different lamp circuits all in series. Taking, as a practical example of this, the original 125 light Brush arc generators with three separate commutator rings, generating upon each one of these practically 2200 volts, the three connected in series will give 6600 volts between the outside brushes connected to the armature, and allowing approximately 300 volts for fields, there will be left 6300 volts at the machine terminals. The drop of potential in the 126 lamps, going around the complete circuit, will absorb this voltage, as indicated in Fig. 2.

To employ the multi-circuit invention to the best advantage upon this generator, the circuit of 126 lamps should be divided into 3 equal circuits of 42 lamps each, and these interposed between the different commutators in the following manner:

Starting in at the negative terminal of the machine, the circuit goes through the fields and thence on to the negative brush on the first section of the armature, through this section and out onto a circuit of 42 lamps; thence it comes back to the negative brush on the second section of the armature, passes through this section to the positive brush, through a second circuit of 42 lamps, and back to the

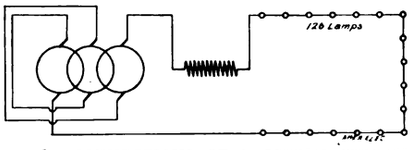



FIG. 1.—CONNECTIONS OF A SINGLE CIRCUIT ARC MACHINE.

negative brush, on the third section of the armature, through it and out to the positive brush through the third circuit of 42 lamps, and returns to the negative terminal of the machine whence it started. This arrangement is shown diagramatically in Fig. 3.

It is quite evident that, considering the voltage generated in the different arma-

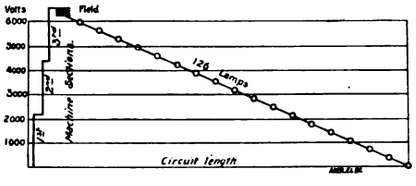



FIG. 2.—RISE AND FALL OF POTENTIAL IN AN ARC CIRCUIT.

ture circuits as plus, and the drop in the different lamp circuits as minus, there will be the following voltages around the circuit:

$$-300 + 2200 - 2100 + 2200 - 2100 + 2200 - 2100 = 0.$$

The voltage between any two of the positive brushes will not be over 300, and the same will be true of the negative brushes. The maximum difference of potential under these conditions will be that between the positive of the third circuit,

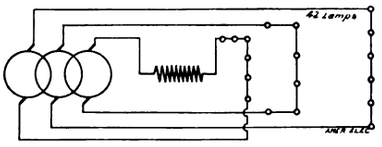



FIG. 3.—CONNECTIONS OF A MULTI-CIRCUIT ARC MACHINE.

and the negative brush of the first section of the commutator, being made up as follows: 2100 volts in line, and 300 volts approximately in the fields, making a total of 2400 volts. The curve of potential gradients for this condition is shown in Fig. 4.

While the generators which the Brush Company was building at the time this in-

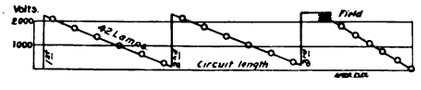



FIG. 4.—RISE AND FALL OF POTENTIAL IN A MULTI-CIRCUIT LINE.

vention was made are perfectly applicable for multi-circuit running from a scientific point of view, from a commercial point of view they are not particularly well adapted to it, due to the fact that it requires too many small lamp circuits.

Six thousand volts on arc circuits are to-day run in a great many cities, and have been run for a long time, and the advantage to be derived from dividing up one of the earlier machines is comparatively slight, for the simple reason that it increases the cost of the arc circuits, and also decreases their efficiency, owing to the increased amount of wire, except in the case of factory and near-by lighting, where there will be no appreciable extra cost of construction and the higher voltage is objectionable. The multi-circuit device can for such cases be attached to any of the earlier generators.

The particular advantage to be gained from the multi-circuit generator is in the station itself, in reducing the number of generators required to supply current to a given number of arc lights with a given maximum voltage, making large savings in the power, floor space, belting, attendance, oil, etc., over many small generators. Another advantage lies in the operation of circuits, due to the fact that it is not necessary that the loads should be divided equally between the two circuits on one machine, but upon machines below 8500 volts, it may be divided in any manner desirable between the circuits, the one regulator keeping the current constant on both circuits.

In the operation of multi-circuit machines, a ground on one circuit or two grounds on one circuit will not affect the operation of the generator. A bad ground upon each of two circuits very seriously affects the operation of the multi-circuit generator, but in this case the two circuits can be readily put in series with the other and the machine run as a single circuit dynamo.

The only advantage of operating two separate arc generators in series upon the multi-circuit plan—as is done in some stations—with the loads divided and interposed between the two would be in the case where one of the circuits was larger than what a single machine would carry, and the other somewhat smaller, the two circuits making the full load or less for the two generators. A disadvantage of this arrangement is the fact that grounds upon the two circuits of a multi-circuit system or group of machines seriously affect the operation of the same, besides which there is some difficulty in getting two automatic regulators to run satisfactorily in series with each other. The best plan in such cases is to cut out one regulator and let the other one care for variations in load.

### BREAKING ARC LIGHT CIRCUITS.

It has been argued against this multi-circuit plan that the full voltage of all sections of the machine is concentrated across any break in the circuit, increasing the strain on the insulation in case of such a mishap.

There is only one practical way for determining wthout elaborate apparatus the instantaneous voltage upon breaking a circuit—namely, the distance which the current will jump. The best method is by connecting needle points, carefully set a given distance apart, across the break, and breaking the circuit many times,

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bringing the needle points gradually closer together until the current jumps.

Fig. 5 gives a curve of the distances between needle points and the direct voltages which will jump over these distances. This curve has been arrived at after a long set of experiments, very carefully made, in which Brush arc generators were loaded up on a resistance and lamp load with needle points set at a

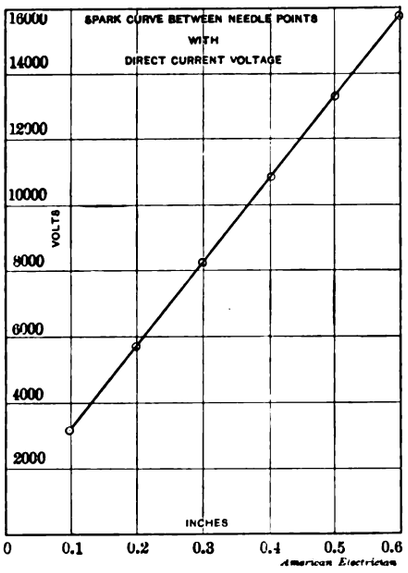



FIG. 5.—SPARKING DISTANCE OF DIRECT VOLTAGES IN AIR.

given distance, and the voltage slowly raised until the current jumped between the needle points.

With this curve as a basis, tests have been made upon breaking a single circuit Brush arc machine in the middle of a lamp load, the capacity of circuit being small. The results showed that the voltage of the machine terminals would not rise 5 per cent. above the maximum voltage which the machine would give under normal operation at full load, and that

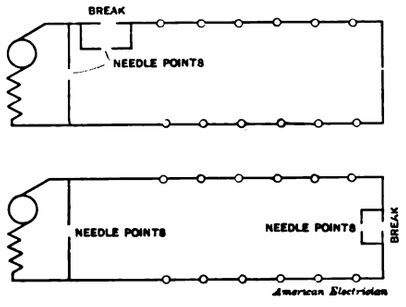



FIG. 6.—CONNECTIONS OF DYNAMOS FOR VOLTAGE TESTS.

at the break, about 60 to 75 per cent. of the normal voltage of the machine would appear, the balance evidently being used up in lamps and line. The same results were found upon breaking the circuit at one end.

Fig. 6 gives diagrams of connections for these experiments. Experiments of the same nature were carried on with a multi-circuit generator, showing a maximum voltage across the break in line, with circuits equally loaded, less than 50 per cent. above the voltage of one section of the generator.

These results are rather surprising, but upon looking into the principles of the open coil arc generators it may readily be seen that the opening of the circuit instantaneously places an infinite load upon the machine, which draws the point of commutation back under the brushes and causes the machine to flash, short circuiting the armature with no damage, and relieving the electrical strain upon the line. In other words, the flashing of an open coil machine acts very much the same as the safety valve on a boiler. The officials of the Brush Company have arranged to show prospective customers at short notice at the Lynn Works of the General Electric Company experiments of this nature, so that they may be thoroughly satisfied that such is the case.

### THE OIL REGULATOR.

To get a better control of the current strength of the Brush arc machine the

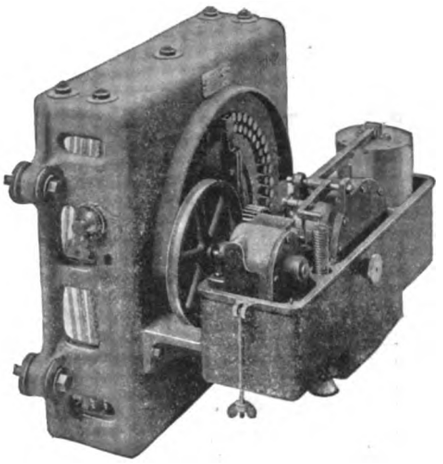


FIG. 7.—THE OIL REGULATOR.

General Electric Company has developed a new type of regulator known as "Form 2," for use instead of the magnetic clutch regulator, until recently in service on such machines. The new instrument, like the old, varies the resistance of the shunt to the series field winding and also adjusts the position of the brushes on the commutator, and is mounted in the same place on the machine, namely, below the commutator and in front of the rheostat in a cast-iron enclosing case. It requires no wall controller. The mechanism consists of an oil pump driven constantly by a belt from the armature shaft and supplying oil through a two-way valve to a rotary piston or vane, the motion of which is communicated to the rheostat arm and brush-rocking mechanism. The position of the valve is determined solely by the magnetic pull of the main solenoid in the series circuit, the restoring force being the usual spring. With an excess current the valve is displaced in one direction, admitting oil under pressure to one side of the main vane and allowing it to be discharged from the other side, while with a current less than normal the reverse action takes place. In the normal position the oil leaks past the valve ports.

The chief advantage of the improved regulator is the fact that the rapidity of its motion is to a certain extent dependent on the variation of the current from normal. Thus, in case of a sudden change

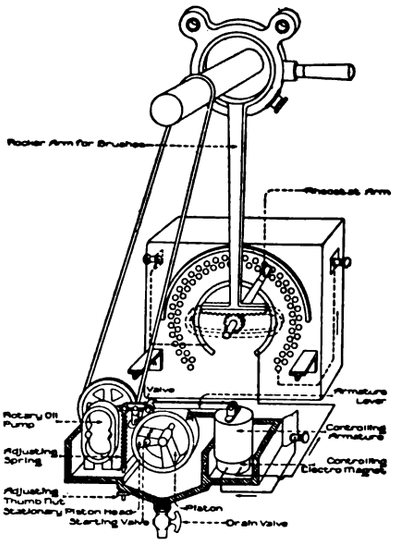



FIG. 8.—GENERAL SCHEME OF OIL REGULATOR.

of load the motion of the regulator is at first rapid, and slows down gradually as normal current is approached. This avoids the hunting or pumping action which occurs with a regulator like the old clutch, which moves at full speed or not at all, and constantly overruns, "hitching" the mechanism back and forth.

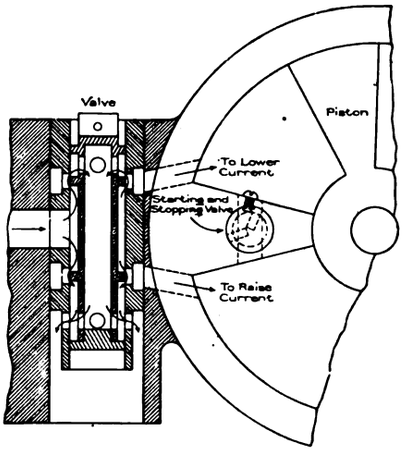



FIG. 9.—SECTION OF OIL REGULATOR VALVE.

There are obviously in the new regulator no sparking contacts and few moving parts, the latter being almost entirely in the enclosing case and partly surrounded by an oil bath. A safety valve is provided to relieve the pump from excessive pressure. The new regulator may be substituted for the former instrument either with or without a new rheostat.

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## TURBINE WHEELS FOR DIRECT COUPLING TO ELECTRICAL GENERATORS.

Unfortunately for the builders of hydraulic power plants, the problem of designing water wheels and generators to run at the same speed so that they may be direct coupled is in many instances more difficult than that of bringing the speeds of dynamos and engines together.

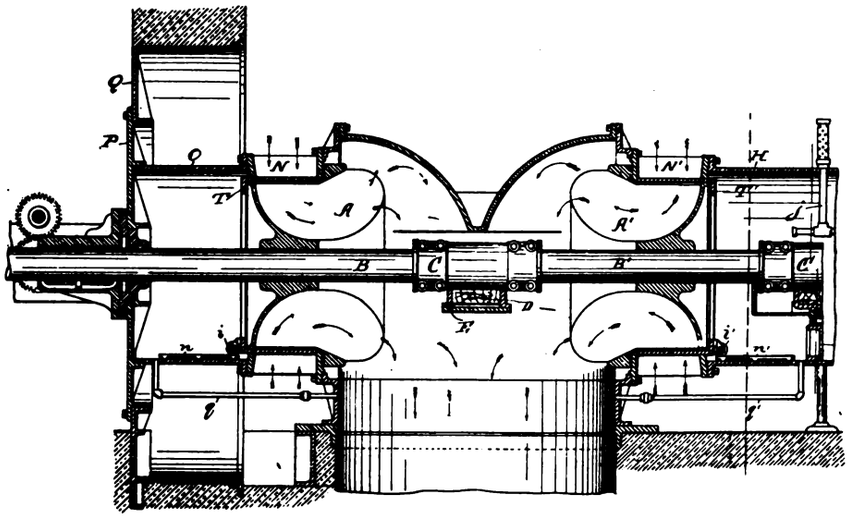


FIG. 1.—VERTICAL SECTION OF VICTOR TURBINES.

Where the head of water is high, from 100 ft. up, the problem is an easy one. A plain bucket or impulse wheel is generally used in such cases and a considerable range of speeds in revolutions per minute, comparable with those in dynamo work, can be obtained by varying the diameter of the wheel, while a range of capacity can be obtained by varying the number of jets acting on one wheel, or the number of wheels on the shaft. As the wheels are narrow, several of them can be readily put on one shaft without occupying much space.

In case of low heads, turbine wheels must be used to obtain any considerable power in a given space and the peripheral speed of these bears such a definite relation to the head of water that a large number of revolutions per minute would make them of ridiculously small diameter and power. In case of direct coupled engine sets the problem becomes more easy in the larger sizes as large dynamos can be economically built at common engine speeds. Single turbine wheels of high powers at low heads cannot be built to run at dynamo velocities, so that heretofore it has been considered necessary to gear a number of vertical shaft turbines to a horizontal dynamo shaft running along immediately above them. The advantages of direct coupling so greatly outweigh this clumsy arrangement that it is far preferable in most cases to place a number of horizontal shaft wheels in a row on one dynamo shaft.

To illustrate the problem, suppose the generator is of 1000 h.p. or 750 k.w. capacity. If, as is usual, it is an alternator, it should run at about 300 r.p.m., as lower speeds give either very crowded poles or an excessive diameter and short axial length of the armature and field magnet structures. With a head of 40 ft. this output could be obtained with a pair of 30 in. wheels of the type described below. If the head is only 30 ft. two pairs of 27 in. wheels must be used; if the head is only 25 ft. three pairs and one single wheel 24 ins. in diameter must be used, all connected on one shaft.

Direct coupling in such cases necessitates, as a rule, horizontal shafts, as the difference between tail water level and high back water and the maximum height of a draft tube is insufficient to place many turbines. The problems of compactly arranging the wheels so as to economize floor space and of coupling them together, and supporting them and their cases so as to keep them in accurate alignment, as well as of operating their numerous speed controlling gates, have been solved for one make of wheels in a most thorough manner by Mr. A. C. Rice. His designs in this direction, as shown in a recent patent No. 621,141, are described and illustrated below.

The wheels for which these improvements were designed are the Victor turbines, as made by the Stilwell-Bierce & Smith-Vaile Company, Dayton, Ohio, and the patents covering the improvements are assigned to this company. The runners of Victor turbines are of the inward, radial flow type with horizontal axial discharge, and those for low heads are as a rule set in an open flume of masonry. An idea of these parts and the improvements in them can be gained from an examination of Fig. 1, which shows a vertical section through a pair of turbines. A and A′ are the runners, the course of the water through them being clearly indicated by the arrows. The two wheels are respectively right and left handed and discharge into a common central draft tube. N and N′ are the guide chutes which give the water a tangential motion tending to turn the wheels. The gates which control the flow of the water and thereby regulate the speed of the wheels are of the register type, cylindrical and sliding directly between the guide chutes and the runners, in which position their throttling of the flow reduces the efficiency less at part gate opening than at any other position in the flume.

The solution of the problems outlined above, viz., economy of floor space, support of all parts in alignment and the operation of the gates, is as follows: In the first place, the dome cylinder, O, which must be provided to receive the gate, T, of the left-hand wheel, is contained within the bulkhead wall between the flume and dynamo room, the opening in the wall being closed by a steel flume head cover, P, bolted to the flume head, Q. This economizes in length a distance equal to the thickness of the wall.

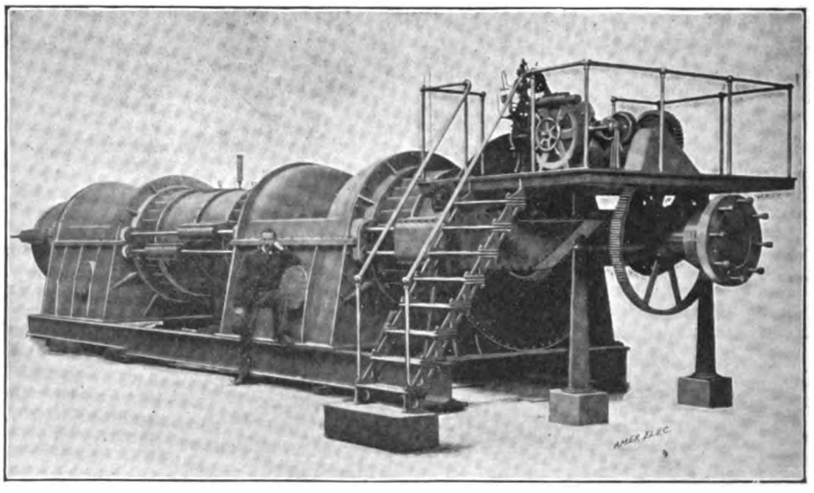


FIG. 2.—VIEW OF FOUR WHEELS ASSEMBLED WITH GOVERNOR.

The gates, T and T′, slide horizontally in the dome cylinder, T moving to the left and T′ to the right to increase the flow of the water. They are supported on roll-

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ers, i and i', running on tracks, n and n'. The dome cylinders into which the gates move when opened are drained of water by means of the pipes, q and q', so as to allow a free movement of the gates. The latter are driven back and forth in response to the demands of the governor by means of horizontal rods running along both sides of the turbines parallel with the shaft, which rods are shown in the photographic illustration of a group of these wheels, Fig. 2. There are two of these rods on each side of the casings, one rod of each pair being attached to alternate gates so that the gates of two wheels discharging into one draft tube are moved in opposite directions. These rods run through packing boxes in the flume head cover, there being within the flume and subject to the action of gritty water, no gears or racks or other wearing parts of the gate operating mechanism, the whole of which is open and free of access in the dynamo room.

The coupling of the shafts is another valuable point. The left-hand runner shown in the figure is mounted on shaft, B, while the right hand is on another section of the shaft, B', and still another section may be coupled to the right. The coupling consists of a split coupling sleeve, C, which also is utilized as a water bearing on the support, D. This makes a greater length of shaft for both the bearing and coupling unnecessary.

The dome cylinder, H, at the right, which contains two gates, is bolted to the chute cases of the wheels to both sides of it, thus keeping them in alignment and supporting the whole from the draft chambers. The right hand water bearing, C', is contained within this dome cylinder and is lubricated by water brought down from the flume through the strainer, k, and pipe, j.

The whole arrangement is one admirably combining a simplicity and rigidity of the parts with a shaping of each piece which makes it easy to cast and simple to assemble, with minimum tool work. The advantages which the Stilwell-Bierce & Smith-Vaile Company obtains through these and other improvements particularly adapt Victor turbines for the driving of large generators, and in fact make this company in many contracts for the development of low heads for large generators direct coupled, the only builder which can bid under the specifications.

## THE PASSING OF THE STANLEY COMPANY.

A review of the history of the Stanley Electric Manufacturing Company was recently given by Mr. William Stanley to a local newspaper, from which the following points have been abstracted:

The Stanley Electric Manufacturing Company started on November 1st, 1890, with a capital of $25,000, and shipped its first goods the first of April, 1891. The original output consisted of transformers and general fittings for alternating current work, Mr. Stanley being a pioneer in this line, having constructed in 1885 and 1886 the first alternating current machinery adapted for the transmission of light or power for any considerable distance.

At the time of the first annual meeting it was shown that in the first six months of actual working time the company earned about $7,500. The capital was increased to $50,000, and the profit during the second year was $18,000, and during the third year $54,000. Afterward the company earned $76,000 yearly on transformers alone.

The Stanley Laboratory Company was also formed for the purpose of carrying on purely experimental work and developing and selling the inventions. In this company the principal stockholders were Mr. William Stanley, Mr. John F. Kelly and Mr. C. C. Chesney, the three men whose surname initials form the well known distinguishing symbols of many kinds of electrical apparatus, S. K. C. These engineers designed and perfected the inductor type of generator, since built in great numbers by the Stanley Electric Manufacturing Company, and did much other pioneer work, especially in alternating current motor and high tension problems.

Mr. Stanley estimates the total production of alternating current apparatus in the United States during the past year as follows: Generators and motors, 120,000 h. p.; transformers. 750.000 lights capacity; meters, 450,000 lights capacity. These three items alone approximately represent an investment of $3,000,000, while the other items which go to make up the alternating current systems easily bring the total value of one year's output of alternating current machinery up to $5,000,000. Of this amount the Stanley Electric Manufacturing Company did a business of between $500,000 and $600,000, its share of the total being no greater, not on account of its inability to obtain business, but because it was not equipped with shops and facilities for any more than this amount of work.

## EXHAUST STEAM HEATING.

After many years of experience on the part of quite a number of electric light and railway companies in the use of exhaust steam for the heating of building in cities, the fact seems perfectly established that a large measure of economy may often be derived from the utilization of this waste product. That steam from boilers can be successfully supplied for heating and power through long lines of pipe laid underground is attested by more than twenty years of direct steam service in cities and villages. Upon the awakening of modern electric development whereby central stations in nearly all cities and towns and have been erected, employing tremendous steam boiler capacity, attention was directed to the waste of an element which could be turned to very practical account.

All steam engineers know that only about ten per cent. of the energy of the steam supplied by a boiler is utilized in the engine and about ninety per cent. is wasted in the atmosphere or escapes in the hot water flowing from the condenser, if condensing engines are used. It was readily seen and demonstrated that the heat thus going to waste could be distributed and sold, and that the demand for steam heat in cities was even more reliable than the demand for electricity for lighting and for power. Because a company was organized primarily to develop and sell electric current it does not follow that it should be prohibited from engaging in a kindred enterprise which could be conducted under the same management and at very little additional expense, and result in great profit to the treasury of the corporation.

In fact, not to put to use this waste product argues a lack of intelligence and thrift on the part of a corporation so offending. Their rivals do not neglect similar opportunities, and a comprehensive view of the situation would lead to putting in force the same tactics. The gas companies could not live if they allowed their by-products to go to waste, and many branches of manufacture thrive and are enabled to pay dividends out of the proceeds from the sale of by-products. Then how can an electric company which can, as many companies are doing, pay all coal bills at the central station for the year out of the sale of exhaust steam during the heating season excuse itself for this lack of acumen?

Some companies are not favorably located to dispose of their steam in this way; that is an excuse, but they are peculiarly unfortunate on this account. With new installations it becomes vitally important to so locate the power plant that a ready market may be found for their exhaust steam. Indeed, in many cases it is a question whether heating from such a station should not become of primary importance, and the electric lighting or power be made incidental on account of being able to utilize only one-tenth of the output of the steam apparatus.

Some have objected to the plan because of the small amount of back pressure which is necessary in order to circulate steam through the underground pipes; but this is no objection, if, as may be readily made the case, the demand for exhaust steam calls for all that comes from the engines. If the revenue from the exhaust pays for the fuel, a difference in engine economy makes no difference. The steam being of a higher pressure becomes in addition a somewhat better conveyor of heat.

In whatever light the subject is viewed, and where the plant is located favorably for steam distribution, as near a district containing many office buildings or other consumers of large amounts of steam for heating, it would seem that business prudence would demand this conservation of waste products.

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# New Apparatus and Appliances

## THE TOERRNIG LONG BURNING ARC LAMP.

Practically the sole cause of the revolution in arc lighting by which the enclosed lamp is driving out the older form of open arc is due to the reduced consumption of carbon and consequent lower cost of trimming. It is therefore manifest that a gain in this direction, other factors remaining the same, is a valuable advance.

The reduced carbon consumption is gained solely by checking the access of oxygen to the arc. In the ordinary enclosing globe there is some leakage of the gases around the bottle cap, which cannot be of one piece fastened hermetically to the globe, since it must be free to move laterally in order to prevent it from binding the carbon and there must be some clearance around the carbon to allow the passage of irregularities through the opening. In many forms the lower carbon comes through the bottom of the globe, giving some chance for leakage at that point. As this leakage is reduced the life of the carbon becomes longer.

In the new lamp illustrated in Figs. 1 and 2 a novel arrangement of the parts is made to minimize the circulation of air into and out from the inner globe. In the first place, as in some previous lamps, the negative or lower carbon holder is brought down within the globe, doing away with an opening at the bottom. The chief novelty lies in the fact that the bottle cap is made a part of a long cylinder or tube which is air tight and encloses the whole of the upper carbon. The arc enclosure thus consists of the transparent inner globe fastened tightly to the lower end of this cylinder, both carbons being entirely within the enclosure.

Another factor that tends to improve arc economy is the high temperature of the inner globe, the light emitted being dependent upon the temperature of the arc, which temperature is maintained under reduced heat dissipation with a corresponding reduction of the power consumed. As most of the heat from the arc rises and is conducted away by the metallic upper portion of the enclosing chamber, this is in the Toerring lamp simply surrounded by the series resistance so as to keep it hot.

By these means the carbon consumption is claimed to be greatly reduced, the maker guaranteeing the lamp to burn 200 hours under ordinary conditions with 12 ins. of carbon, the arc being adjusted to about 85 volts, and claiming that it has burned under the same conditions over 300 hours.

The means of trimming and adjusting the lamp will also appeal to those who use it. With the inner globe removed the upper carbon is simply pushed up through the lower carbon holder and the clutch and into the sheath which encloses and carries current to it. The negative carbon is pushed in after it and is simply broken off with plyers if it protrudes below the holder, no measurement or cutting to gage being necessary.

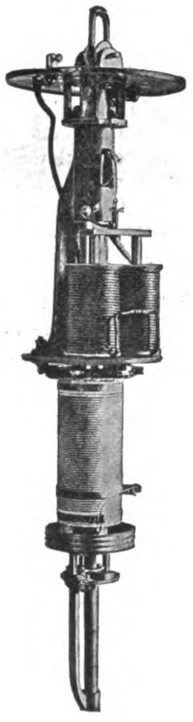


FIG. 1.—THE MECHANISM OF THE LAMP.

The brass threaded spinning which holds the inner globe to the cylinder forming the upper part of the enclosure is readily removable with the inner globe, so that the lamp may be trimmed when hot. By simply lowering the outer globe to the position shown in Fig. 2, the resistance becomes accessable.

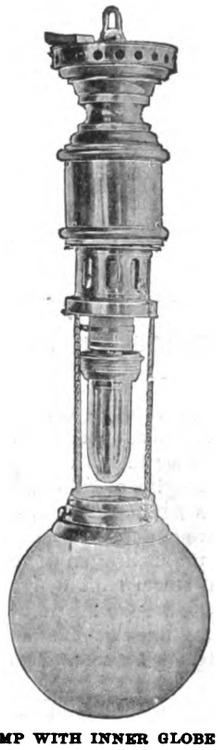


FIG 2.—LAMP WITH INNER GLOBE LOWERED.

The rheostant consists of a high resistance wire laid in a helical groove formed on the surface of a porcelain cylinder. This construction adds to the head radiating surface and permanently holds and separates each turn of the wire on a fireproof structure. The resistance is changed by clamping a strap about the cylinder, and in contact with the wire at any desired position.

The construction of the regulating mechanism is entirely of fire-proof materials. The clutch is located within the enclosing globe and operated by a double magnet, shown in Fig. 1, pulling downwardly on an armature attached to a chain running over a small pulley.

The lamp is short, measuring 26 ins. over all and weighing about 18 lbs. with the globe. It is made for 110 and 220 volt direct current circuits, a 500 volt and series lamp being in course of development.

The lamp was designed by Mr. C. J. Toerring, who has had no little experience in this line of work with various lamp manufacturers, notably the Helios Electric Company. The maker of the lamp is the C. J. Toerring Company of Philadelphia.

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## AN IMPROVED ELECTRIC SOLDERING IRON.

After many attempts to produce an electric soldering iron that would be perfectly satisfactory in every respect, the United Electric Heating Company, Detroit, Mich., has placed upon the market the iron shown in Fig. 3.



FIG. 3.—AN ELECTRIC SOLDERING IRON.

This iron is compact and short and very light in proportion to its size, being, in fact, much lighter than the ordinary solid copper iron of the same size or intended for the same class of work. This result has been accomplished by the use of aluminum in the main body of the iron and by making the copper portion no more than a tip, instead of the long piece required to store heat in an ordinary iron.

There is no deterioration in the aluminum core, as this metal is not affected by either acid or acid fumes, or by heat, as it does not oxidize as will brass, iron or other metals. The aluminum core is a very good heat conductor and is so constructed that the heat generated is conducted to the copper tips where needed, and is prevented from being transmitted to the handle by a ventilator placed at handle end of the core. This is an important feature, as the heat generated is concentrated where needed and loss due to transmission to undesirable parts of the iron or by radiation is small, making the iron efficient. The copper tips are made detachable and interchangeable, so that any size or shape of tip may be used on one iron.

The iron attains full heat in about three minutes after the curent is turned on and is then ready for continuous use.

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### A STORAGE BATTERY BOOSTER.

The Bullock Electric Manufacturing Company, Cincinnati, Ohio, has recently shipped to the La Capital Company, Buenos Ayres, S. A., a booster to be used in connection with the extensive electric railway system of this company.

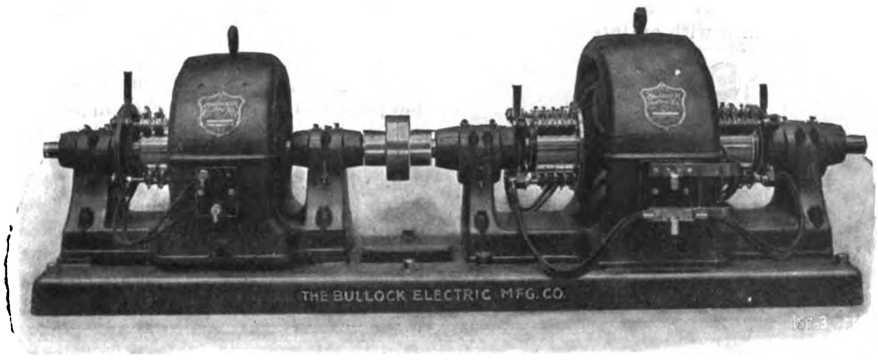



FIG. 4.—A MOTOR-DRIVEN BOOSTER FOR A RAILWAY STORAGE BATTERY.

Fig. 4 clearly shows the general features of the machine, which consists of a generator driven by a 100 h. p. motor adapted to use current from the railway feeders varying in pressure from 550 to 650 volts. At the latter pressure the speed is 1000 r. p. m.

The generator has a double commutator and is compound wound with a capacity of 1000 amperes at 60 volts or 500 amperes at 110 volts. Provision is made at the switchboard for using the shunt and series coils separately or together. The machine is equipped with a shaft oscillator, which is of the automatic magnetic type. The machines are rigidly connected by a flanged coupling and are mounted on a heavy iron sub-base, which gives accurate alignment.

This is the second booster the Bullock Electric Manufacturing Company has furnished the La Capital Company. High grade machinery is naturally selected for this far-off installation, as failure so far distant from the source of production would be disastrous to the business interests of the operating company.

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### A LOW-PRICED MEDICAL BATTERY.

In line with its other devices for obtaining interesting electrical effects on a small scale and with low-priced apparatus the Knapp Electric & Novelty Company, New York City, has recently brought out what is called the Knapp "Shocko" medical battery, a view of which is shown in Fig. 5.

The whole arrangement consists simply of a single "elektric" dry cell mounted on a base board with a simple induction coil and fitted with a pair of handles and a combined vibrator and switch. The dry cell is fastened down by means of a sheet of metal bent around it and can be replaced by simply loosening the screws fastening this sheet down to the base board and taking out the one wire attached to the carbon terminal. The zinc shell of the battery makes contact with the sheet metal fastening without the use of any wiring.

On the sheet metal fastening is pivoted the switch, which in turn carries one contact of the vibrating make and break device. A movement of this one device closes the circuit and adjusts the contact.

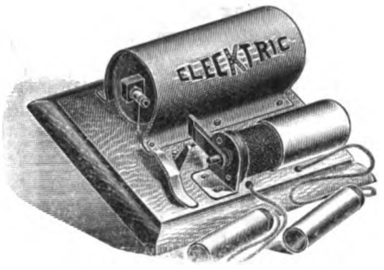



FIG. 5.—A SIMPLE INDUCTION COIL.

The coil is wound on a wooden spool and provided with a cylindrical sheet metal short-circuiting tube, which can be slipped on or off to any position to adjust the strength of the shock. A pair of hand electrodes completes the instrument.

### A DIRECT GEARED MOTOR DRIVEN PUMP.

The pumping outfit shown in Fig. 6 is especially designed for use in breweries, mines and similar places where a rugged, sturdy machine, capable of withstanding considerable abuse, dampness, etc., is desired. The complete outfit is very compactly arranged on one base plate, the double reduction gearing being arranged vertically so that the floor area is kept down to that of the plate. The motor is of the Bernard enclosed type, specially fitted for this purpose with a journal on one end of the shell. It is in line with the rotary pump, which is of the positive action type, running at about 60 or 70 r. p. m.

While the motor appears to be of very large size compared with the pump, this is due to the fact that an enclosed motor is necessarily of generous proportions in order to dissipate the heat generated by it, and the pump may act against considerable heads, requiring a large amount of power. The strength of the apparatus is apparent from the fact that in spite of the size of the motor and the great leverage it obtains by means of the double reduction gearing, the outfit is so designed that it may be stopped at any time, if fitted with a circuit breaker, by simply putting a kink in the hose attached to the delivery, the extra load thus thrown upon the motor opening the breaker without injuring any of the parts thus strained.

The manufacturer of the complete outfit is the E. G. Bernard Company, Troy, N. Y.

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### THE ROBERTS BORING MACHINE.

The loss of time and inconvenience of erecting scaffolding for working from the top of ladders when boring holes through overhead joists are hardly realized by wiremen and contractors who have be-

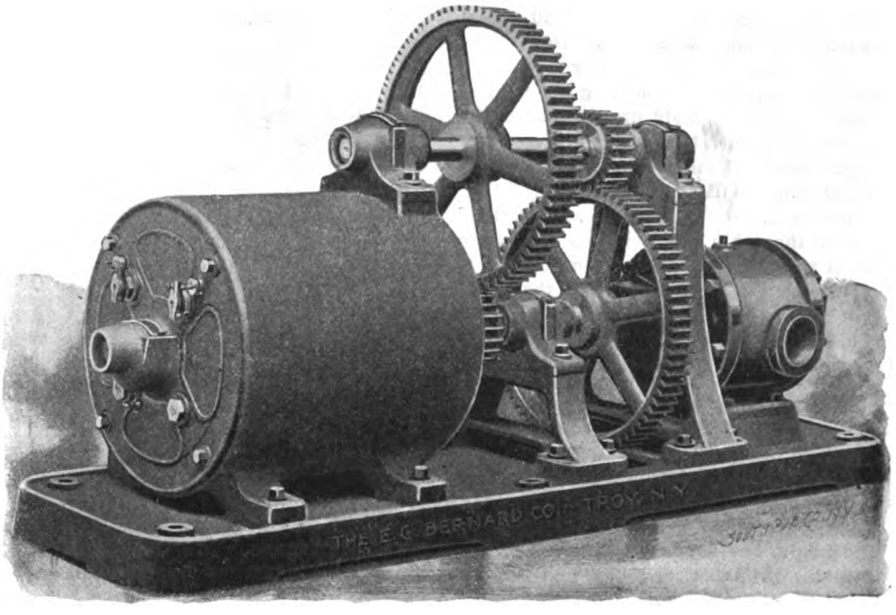



FIG. 6.—A MOTOR-DRIVEN BEER PUMP.

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come habituated to such work. The time spent in getting in place is invariably more than that spent in boring the hole, and the comparative ease of working from the floor is enormous.

The apparatus shown in Fig. 7 holds a bit on the upper end of a long upright

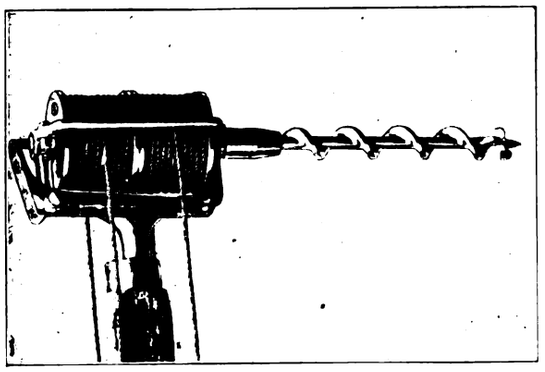


FIG. 7.—A JOIST BORING TOOL.

which may be extended from 7 to 16 ft. in length to reach ceilings between those heights. The lower end of the upright rests upon the floor, where the operator stands and turns the bit by means of a pulley carrying cables and a ratchet, which, when the cable is rewound prevents the bit from being turned out. A small chain, not shown in the cut, reverses the ratchet so that the bit may be turned out when the hole is completed.

The machine is covered by patents and made by Jas. McCrea & Company, Chicago.

### A CABLE SUPPORTING CLIP.

The improved holdfast cable clip, shown in Fig. 9, is quickly and easily applied by hand and can be readily removed from time to time for new work without impairing its holding power. The metal strap is simply drawn around the cable and passed through the hanger, the part with the hooks is then turned up, as shown in the illustration, which action takes up the slack, binds the strap tightly about the cable and prevents the latter from slipping. All parts are made of galvanized steel or zinc, so that they will not rust or in any way injure the cable. This clip is made by James S. Barron & Company, New York City.

### SOME ERICSSON TELEPHONE APPARATUS.

In spite of the extremely rapid development in this country of manufacturing houses building telephone apparatus for independent exchanges, the comparatively ancient establishment of Ericsson in Stockholm has not been distanced in the race for the latest and best and has an edvantage over its younger competitors in the experience it has gained through long years of practice.

Ericsson & Company of this country have lately imported some new lines of Ericsson apparatus, some details of which are illustrated and described below.

In Fig. 10 is shown the new Ericsson Swedish bipolar all-metal Samson receiver. A feature of this instrument is that it has a brass shell covered with a hard rubber tube. The magnet is fastened to this shell by screws near the front end and is provided with an internal arrange-




FIG. 8.—A MICROTELEPHONE WITH AN INTERCOMMUNICATING SWITCH.

ment for adjusting the distance between the poles and diaphragm, which adjustment cannot be changed after the magnet is screwed in place. The structure being entirely of metal, no further adjustment




FIG. 9.—A HOLDFAST CABLE CLIP.

is necessary. The head is made of brass, nickel plated, the metal giving the instrument much better acoustic properties than those of the comparatively dead materials, so far as sound is concerned, hard rubber



FIG. 10.—THE ERICSSON SAMSON RECEIVER.

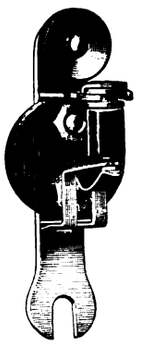


FIG. 11.—A HEAT COIL SNEAK CURRENT ARRESTER.

or its imitations. The diaphragm is nickel plated, as are the ends of the bipolar magnet, to prevent these parts from rusting.

Another detail of interest is Ericsson's Swedish lightning protector, a view of which appears in Fig. 11. This is built on the heat coil circuit breaker principle, a small coil surrounding a fuse which is attached to a button slipped under a downwardly pulling spring. In case of any sneak current the fuse is melted, the button is released and the spring flies downward, opening the circuit by an inch or more.

Another popular piece of apparatus is that shown in one form in Fig. 8. To the left is the coal-grain hand microtelephone, fitted with a hand contact in its grip, which serves in place of the hook switch in the ordinary telephone set. This hand contact is fitted with front and back needle point contacts of platinum, cutting in the bell in the normal position and the battery and induction coil when pressed by the fingers. The particular advantages of such an instrument over the ordinary form with the microphone attached to the wall or desk fixture are the facts that if by mistake it is laid down the line is not thrown out of use and the user can neither get an improper distance from the microphone, nor is he liable to turn away from it, the instrument retaining its proper position in front of the mouth, no matter whether he turns around or not. This is made up for use as either a wall or desk or interior telephone, the illustration showing the latter combination. When used on the desk the microtelephone is simply laid or hung anywhere, and no standard with hook switch and microphone is necessary.

The company also has now a swinging switchboard transmitter in addition to its breastplate transmitter formerly carried, a new transmitter arm with concealed cord and binding posts, a carbon lightning arrester and a repeating coil specially designed for what is called "duplex" working. By this use of the word "du-

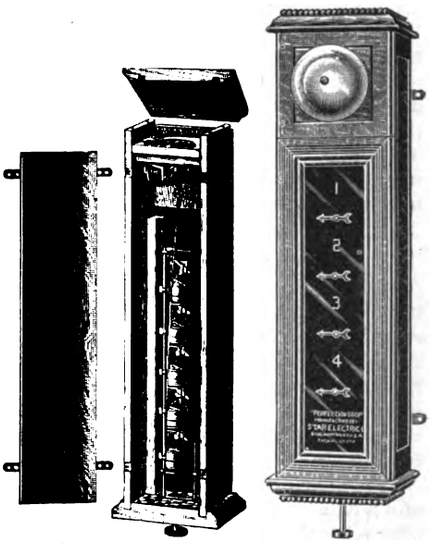



FIG. 12.—THE PERFECTION DROP ANNUNCIATOR.

plex" is meant the operation of three metallic circuits on four wires. Two of these wires are used in the usual way for one circuit and two for one other with repeating coils at the end of each. The third circuit uses the two wires of one of the other circuits for one side of its line and

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the two wires of the other for the other side of its line, and is obtained by simply tapping metallically into the center turns of the line sides of the repeating coils.

The company has many other improvements and refinements, such as what is called the even balanced talking circuit, consisting of microphone, induction coil and receiver with the proper relative resistances, so as to get maximum talking effect at the receiving end.

### THE PERFECTION DROP ANNUNCIATORS.

In the ordinary annunciator the indicator is held up against the force of gravity by a trigger attached to the operating armature. In case of jolting in car, steamship and elevator service, the annunciator is frequently mechanically tripped, giving false indications, which seriously impair the reliability of the instrument.

In the annunciator shown in Fig. 12, to which the ambitious name at the head of this notice applies, the armature operates the indicator directly instead of releasing it and allowing it to be operated by some other force. The indicator is caught when in the horizontal position and held there until released by the restoring rod. The indicator is thus liable to be shaken loose only during the brief interval when it is down instead of during the comparatively long interval when it is up. In the case of a 100-drop annunciator there may be on an average one indicator down at a time and 99 in the up position, and mechanical jarring is likely to affect only the one instead of the ninety and nine.

The instrument is made by the Star Electric Company, Binghamton, N. Y.

### A BOILER PLANT WITH A SMALL REPAIR ACCOUNT.

Quite a remarkable instance of low cost of maintenance of steam boilers recently came to light when the Wagner Palace Car Company decided to make some changes in the boiler plant of its shops at East Buffalo, N. Y. The original equipment, installed over 9 years ago, consisted of five 150 h. p. porcupine boilers, built by the Hazelton Boiler Company, New York City. These were set in the standard brick work commonly used at that time. When the changes came up it was decided to refit them with the Hazelton Company's new type of steel casing or jacket, the battery of boilers after this change having the appearance shown in Fig. 13.

Not a dollar has ever been expended upon them in repairs and when the change was made last Spring the boilers were found in excellent condition. The new steel casings are made so that the fire-brick linings of the furnace can be removed and new fire-brick lining placed without disturbing the upper sections of jacket. The tubes can be removed at any time from the inside of main cylinder of boiler and new tubes inserted on the inside. The sections are provided with doors as the illustration shows, through which a hose may be inserted and a jet of steam or compressed air blown around the tubes to clean them of soot.

The interior construction of the boiler is shown by the vertical section, Fig. 14. From this it will be seen that the heating surfaces consist of a number of straight horizontal tubes radiating from a central vertical cylindrical shell, giving the straightest course for the flue gases from the fire to the stack and yet a course where they are continually compelled to eddy about the heating surfaces.

The circulation of steam is maintained in the upper tubes and a certain amount of drying or of superheating is obtained by taking the steam from an interior drum fitted with small tubes drawing steam from the ends of the larger tubes, as the illustration shows.

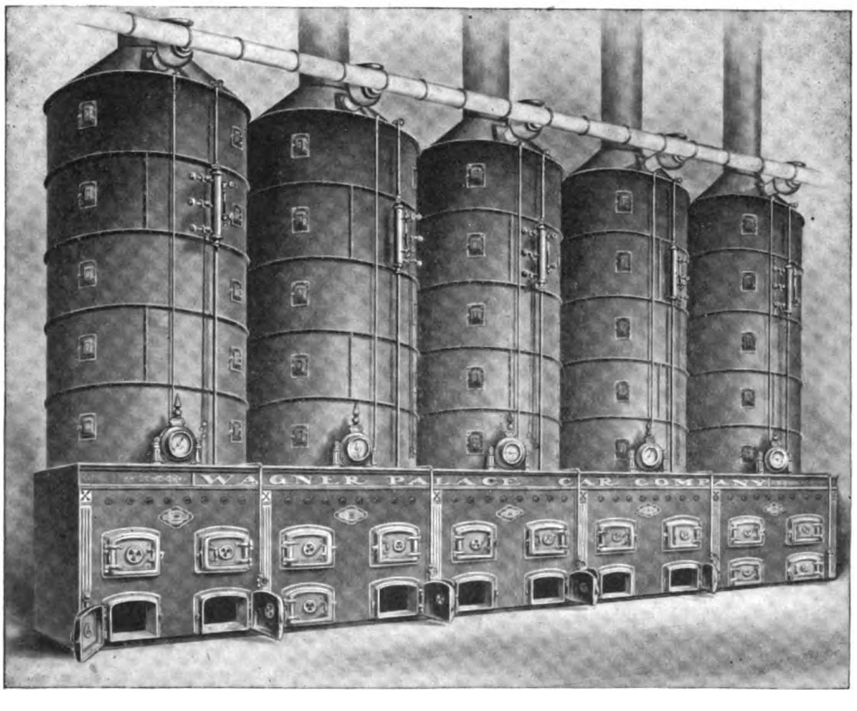



FIG. 13.—THE BOILER PLANT AT THE WAGNER PALACE CAR WORKS.

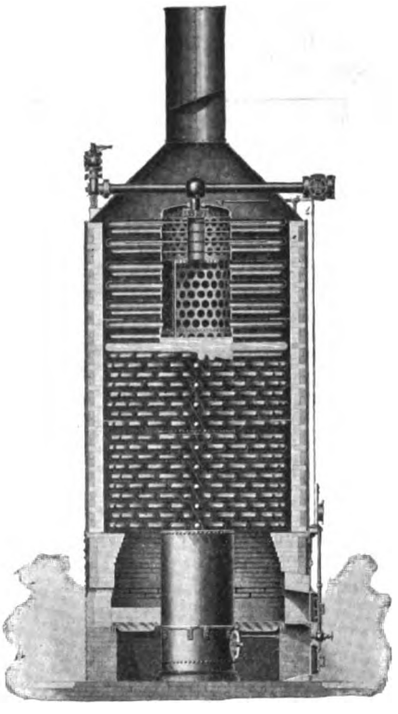


FIG. 14.—SECTION OF PORCUPINE BOILER.

The instance given above of low cost of repairs is in line with other experience with the same boilers, the company claiming that boilers of this make have been in use for 19 years and are still running, on which no repairs have ever been made. On the entire output for 20 years the company claims that less than ¾ of 1 per cent of the first cost has been expended for repairs and that 90 per cent of this amount has been on the boilers of one concern, which is crowding its equipment far beyond the rated horse-power for which the boilers were constructed, the officials of this concern considering it more economically to occasionally renew the tubes than to put in more boilers.

### THE SINGLE VALVE TANDEM COMPOUND TYPE OF THE HARRISBURG SYSTEM OF ENGINES.

Under certain conditions it pays to compound high speed single valve engines with fly wheel governors. These conditions are: High cost of coal, intelligent attendance, boiler pressures from 110 to 150 lbs. and engine capacities above 75 h. p. The use of a compound in place of a simple engine, where most of these conditions exist, effects a saving of fuel which warrants the additional cost of the more elaborate engine. Under average conditions of load and size the steam consumption of simple, high speed, single valve engines runs from 30 to 35 lbs. per h. p.

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hour, while that of similar compound engines is only from 22 to 26 lbs., or even from 18 to 20 lbs. with condensing apparatus.

The Harrisburg Foundry & Machine Works, Harrisburg, Pa., manufactures among the various types of its complete system both simple and tandem compound, horizontal, high speed, single valve engines, and advocates the use of the latter under the conditions which, as outlined above, warrant the compound type. The construction of this engine is shown in Fig. 15. The low pressure cylinder is placed next to the engine frame, this arrangement giving the outer and smaller cylinder a more substantial attachment to the frame than the smaller cylinder would give the larger if the parts were interchanged. The connection between the two cylinders is itself cylindrical in shape and larger than the low pressure cylinder head, so that the latter may be unbolted and slipped back along the piston rod to allow the adjustment of the packing rings of the low pressure piston without taking down the high pressure cylinder and its piping. The connection is cut away at the two sides to permit this easy access to the head of the low pressure cylinder as well as to the two stuffing boxes. The high pressure cylinder is supported by means of the connection between the two cylinders, which connection rests upon the extended sub-base casting. The connection rests upon the sub-base through a tongue and groove, and is fastened down through slotted bolt holes. This arrangement allows horizontal motion in the direction of the piston rod, thus taking up thermal expansion and contraction without strains.

The receiver and steam passage way between the high and low pressure cylinders is a flanged casting, hung beneath the steam chests. In the smaller sizes both the high and low pressure valves are operated by one eccentric actuated by the centrally balanced centrifugal inertia governor, the accompanying illustration representing an engine with this arrangement. The larger sizes are, however, built with two separate eccentrics, one fixed and driving the low pressure valve but fitted so that the cut-off may be set by hand to properly distribute the work between the two cylinders for the average load that the engine is called upon to perform. The high pressure valve is then alone driven by the governor eccentric.

Further valve adjustment is obtained by the construction of the heads of the piston valves which are adjustable as regards both lead and lap, to suit any changed conditions of working, such as a new boiler pressure or the removal or addition of condensing apparatus. By these means one engine may be adjusted without new parts to give satisfactory working and the highest economy under various requirements.

These engines may be and are made in the center crank, self-oiling style of the Ideal engine, which is another and older type of the system of engines made at the same works.

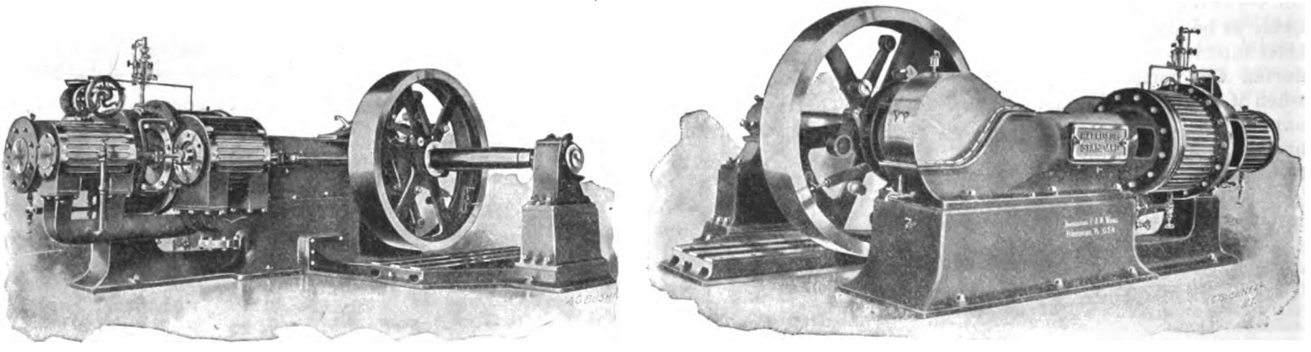


FIG. 15.—VIEWS OF THE HARRISBURG SINGLE VALVE TANDEM COMPOUND ENGINE FROM BOTH SIDES.

## NEW BOOKS.

Practical Electricity. By J. C. Lincoln. Cleveland. Pocket Edition. The Cleveland Armature Works. 286 pages. Illustrated. Price $2.

This work is the outcome of a series of lectures on the design of dynamos and motors, embodying the results of daily shop practice. The work as now published is intended for those who have some practical knowledge of electricity and desire to obtain a further insight into the calculation of circuits and the methods of constructing and wiring dynamos and other electrical machinery. Each chapter is followed by a number of questions, the answering of which will test the reader's comprehension of the previous text and tend to fix the ideas in his mind. Correct answers to the questions are to be found at the end of the book. The work is extremely simple in style and correspondingly elementary in character.

The Elements of Physics. By Henry Crew. New York; The Macmillan Company; 342 pages; illustrated. Price, $1.10.

This work, which was designed especially for use as a text book in high schools, is written in unusually clear and simple style. While elementary mathematics and precise terms are, to a certain extent, necessary, they are avoided as far as possible in favor of the plainest and simplest of English. The various physical laws are explained in a simple, practical manner, which makes each division of the book readable and interesting. What appears to be a hobby of the author and is followed through the work, is the recognition of the intimate relation of all departments of physics and the unity of the laws of nature which have been discovered therein. The student is led through the various departments of mechanics, sound, heat, electricity and light, with this idea in mind, the arguments of one department being based upon the conclusions of those preceding, and the deductions explained by analogies thereto.

## LEGAL NOTES.

A. L. IDE & SONS, Springfield, Ill., have brought suit in the United States Circuit Court, St. Louis, Mo., against users of Chuse engines, praying for an injunction against the infringement of patents on lubricating devices.

THE GENERAL ELECTRIC TROLLEY CONTACT-SPRING CASE. — The General Electric Company has obtained in the United States Circuit Court, District of New Jersey, an opinion of Judge Kirkpatrick sustaining the claims of Patent No. 412,155, granted to Albert Anderson on trolley contact springs. The opinion was delivered in the case against the Rahway Electric Light & Power Company and was filed August 1st, 1899. The patent covers the use of contact springs within the trolley harp and bearing on the ends of the hub of the trolley wheel. The defense was lack of patentable novelty in view of the prior art, which was completely set aside in the Judge's opinion.

THE WESTERN TELEPHONE CONSTRUCTION COMPANY, Chicago, has been granted a favorable decision by Judge Bretano of the Superior Court of Cook County, in a suit brought by Madison B. Kennedy, a stockholder of the company, asking for a receivership, which case has been under litigation for some two years past. The allegations in this case and the rumors which have spread through the trade on account of them have been a serious trial to the Western Telephone Construction Company, and particularly to its president, Mr. J. E. Keelyn. The Judge's opinion entirely clears them aside and comments strongly upon the lack of a cause for the charges. The company states that of all the hundred and more law suits in which it has been either complainant or defendant during the last six years, it has invariably been victorious.

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THE MULTI-GLAZED INSULATOR INTERFERENCE.—Mr. Fred M. Locke, Victor, N. Y., has announced that the insulator comprising two or more shells of porcelain nested and fused together with glaze has been decided by the examiner in the Patent Office to be the invention of Mr. Locke. Mr. Locke filed his application for letters patent in February, 1897, and, in August of the same year, Mr. Boch, of the R. Thomas & Sons Co., of East Liverpool, Ohio, filed an application for the same thing. An interference was declared between the two applications and also between Mr. Locke and a patent granted March 8, 1898, to Mr. Boch, which comprises substantially the same invention, except that the parts were fused together with extra glaze. Interference proceedings have been pending since September, 1897, and a few weeks ago the Patent Office decided that Mr. Locke had proved "that Locke was the first to conceive, disclose and reduce to practice the invention in issue; judgment of priority is awarded to Fred M. Locke."

In the second interference with the patent of Mr. Boch the examiner held that "whichever party is entitled to prevail as to the issue in one interference is equally entitled to prevail in the other; the fact in this instance, the burden of proof is upon Locke and that Boch is the patentee is of no moment, for to the examiner's mind Locke has established his claims of priority beyond a reasonable doubt. Judgment of priority of invention is awarded to Fred M. Locke."

## PERSONALS.

MR. W. J. JOHNSTON, until recently proprietor of the "Electrical World," sailed August 17th from San Francisco on a trip around the world. Mr. Johnston will spend some time in the Hawaiian Islands, Japan, China, India, Egypt, etc.

MR. ARTHUR WARREN, manager of the advertising department of the Westinghouse Electric & Manufacturing Company, returned from Europe on Aug. 5. While on the other side he was busily engaged in the exploitation of the new Westinghouse manufacturing company in England.

MR. GEORGE A. THOMPSON, who was formerly connected with the Short Electric Railway Company, the Forest City Electric Company and other well known Western concerns, has been appointed Eastern representative of the Adams-Bagnall Electric Company, the well known arc lamp manufacturers, in place of Mr. C. W. Phipps, resigned, and is now established at the company's New York office, 222 Havemeyer Building.

MR. J. H. HALLBERG, who has been for the last three years electrician for the Standard Thermometer & Electric Company, has resigned this position to accept a similar one with the arc lamp department of the General Incandescent Arc Light Company, New York City. During Mr. Hallberg's connection with the former company he designed and perfected the Midget enclosed arc lamps. His work with the new company will be in the line of arc light designing and perfecting. Mr. Hallberg takes charge of his new duties on or about September 1st.

MR. G. W. HUBLEY, Louisville, Kentucky, now represents as sole agent for that state, the American Electric Vehicle Company of Chicago, and hopes soon to introduce into his territory many vehicles of this company's make. His duties in this connection will not interfere with his position as Superintendent for the Louisville Electric Light Company. The example of Mr. Hubley in this connection would be a good one for other central station superintendents to follow, work of this kind being such that it can be done without interfering with their regular duties and giving every prospect of proving profitable both for the individual undertaking it and the central station.

MR. ISAAC L. RICE resigned on August 17th his position as president of the Electric Storage Battery Company. First Vice President Geo. H. Day was elected his successor. Mr. Rice gives as a reason for his resignation lack of time to attend to the affairs of the company. He remains a member of the board of directors and retains his financial interest. Mr. Rice wil remain at the head the Electric Vehicle Company and the Siemens & Halske Company. Mr. Day, who succeeds Mr. Rice, is the Vice-President of the Pope Manufacturing Company and prominently connected with the Columbia & Electric Vehicle Company.

MR. J. J. SWANN, until recently Associate Editor of "Engineering News," and in charge of the articles on electrical subjects appearing in that periodical, has accepted a position with the Ingersoll-Sergeant Drill Company. Mr. Swann will have complete charge of this company's exhibit at the coming international exhibition in Paris, and in that capacity will spend the year 1900 in the French capital. Mr. Swann's wide knowledge of electrical and mechanical engineering gained in his editorial work will be to his advantage in his new field, his acquaintance with electrical engineering and some of its limitations being of particular value in the development of the general applications of compressed air, now being aggressively advanced by the Ingersoll-Sergeant Company.

## TRADE PUBLICATIONS.

THE GOLD CAR HEATING COMPANY, New York and Chicago, has published its catalogue of 1899 and 1900, covering all its systems of car heating, including the electrical.

STEAM WITH SOFT COAL WITHOUT SMOKE is the title of a new 50-page illustrated circular issued by the Murphy Iron Works, Detroit, Mich., sole manufacturers of the celebrated Murphy automatic smokeless (stoker) furnace.

THE MAINTENANCE COMPANY, New York City, is circulating to its friends and the trade generally a convenient glass paper weight, covering an attractive illustration pointing out the purpose and character of the company's work.

THE HARRISON SAFETY BOILER WORKS, Philadelphia, Pa., have issued a treatise on feed water heaters and steam separators, setting out the meritorious points of these devices in general, of open heaters in particular, and of Cochrane heaters and oil separtors in detail.

THE INTERNATIONAL CORRESPONDENCE SCHOOLS, Scranton, Pa., have published a general circular on their work as well as notes which they are now circulating calling attention to special privileges which are extended to all who enroll in the schools before October 1st, 1899. The special privileges consist of reduced rates on a complete set of drawing instruments.

THOMPSON, SON & COMPANY, New York City, have recently published a price list of second-hand electrical apparatus which they now have on hand. The line is a very elaborate one, showing the magnitude of the business the firm is now carrying on. The list contains a large amount of 110 volt, 220 volt and 500 volt direct current machinery as well as arc dynamos, transformers, open and enclosed arc lamps, etc.

THE BULLOCK ELECTRIC MANUFACTURING COMPANY, Cincinnati, Ohio, has published under date of August, '99, a bulletin of its engine type generators. The new bulletin describes and illustrates the well known features of this type of machine, viz., the cast yoke with bolted laminated field poles and separately wound series and shunt field spools, the brush holder ring carried on three rollers from the yoke ring, the radial brushes, etc.

THE CUTTER ELECTRICAL & MANUFACTURING COMPANY, Philadelphia, has brought out a small pamphlet entitled "Indications," containing the records of a number of tests with I. T. E. circuit breakers carried out some by Prof. W. M. Stine of the Armour Institute, and some by Wm. McDevitt, inspector of the Philadelphia Board of Fire Underwriters. In addition to these tests, which show up very favorably for I. T. E. breakers, the pamphlet contains letters of recommendation from other fire and wire department officials and large consumers. The tests described and the tables given are of no little interest to those in doubt between fuses and circuit breakers.

THE WESTINGHOUSE MACHINE COMPANY, Pittsburgh, Pa., has brought out a new catalogue of the Westinghouse, Junior, engine. The new catalogue explains in the clear and well illustrated style of Westinghouse catalogues, the meritorious points of the engine. One of these is the extreme simplicity of the crank shaft, in which there is no center bearing inside the case to give trouble, the shaft consisting of a billet of open hearth steel bent to the proper S shape between a set of dies. Another good point is the modification of the inerta governor so that it may be run in either direction by simply changing over the tension spring from one side of the weighted arm to the other.

THE B. F. STURTEVANT COMPANY, Boston, has recently published an illustrated catalogue of Sturtevant engines for electric light plants and general high-grade work, as well as two bulletins, one on the Sturtevant 8-pole motors and generators described in the August issue of the American Electrician, and the other on the Sturtevant motor driven fans. Sturtevant generating sets, consisting of enclosed high speed, two-crank engines, compactly arranged with a generator on one bed plate, while specially designed for marine service, are admirably adapted to isolated plant work where economy of space is a consideration. The Sturtevant ventilating fans are also of value in isolated plants, especially in office buildings and similar locations where forced ventilation is necessary.

THE OKONITE COMPANY, LTD., New York City, is circulating a very complete electric wire computer designed by Mr. William Cox. The computer is mechanical in character on the principle of the slide rule, made of cardboard in a circular disk or wheel form and bound in neat covers. By turning the disk until the required drop in potential in volts of one scale meets the required current in amperes of another scale, the required circular mils as well as the size of the wire on the B. & S. gage can be found, practically opposite the number representing the length of the circuit in feet. Similarly any three of the four factors involved in the calculation being known, the other can be found. The computer is of great convenience where much calculation of the proper size of wire for a given drop or of the drop under given conditions must be made.

## BUSINESS NEWS.

THE STIRLING COMPANY is making extensive additions to its boiler building plant at Barberton, Ohio.

THE MOUND TOOL & SCRAPER COMPANY, St. Louis, Mo., announces that it has recently shipped 12 sets of scraping tools to Honolulu.

THE SIEMENS & HALSKE ELECTRIC COMPANY OF AMERICA announces that it has removed its New York office to rooms 319 and 320 of the Havemeyer Building.

THE ELECTRIC STORAGE BATTERY COMPANY has removed its New York office from 20 Broad Street to the 15th floor of the American Surety Building, 100 Broadway.

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THE CLAYTON & LAMBERT MANUFACTURING COMPANY anounces that it has moved from Ypsilanti to its new factory in Detroit, Michigan, where it has superior facilities for the manufacture of torches, blow pots, etc.

THE PACKARD ELECTRIC COMPANY, Warren, Ohio, manufacturer of incandescent lamps and transformers, announces that Messrs. Mayer & Englund of 10 S. 10th St., Philadelphia, Pa., have taken the agency for its incandescent lamps for street railway use.

THE ANNUAL CLAM BAKE OF THE AMERICAN ELECTRICAL WORKS will be held on September 9th at the Pomham Club, Providence, R. I. Mr. Eugene F. Phillips has sent out a novelty in the way of invitations, which are stamped on thin copper sheets.

MR. GEORGE W. LORD, Philadelphia, the manufacturer of Lord's boiler cleansing compounds, reports that he was never busier since he has been in business than at present. He recently shipped to Brazil 10 tons of his boiler compounds in response to the third order from the same source.

THE WESTERN ELECTRIC COMPANY will erect a new ten-story factory in New York City. Plans have been submitted to the Building Department calling for a brick and terracotta structure on a plot 105 by 140. The new building will cost, according to the present estimate, $450,000.

MR. SEARS B. CONDIT, JR., has severed his connection with the Chase-Shawmut Company and has opened an office at 63 Oliver Street, Boston. He will do general repair work and act as manufacturers' agent for a number of good specialties which he already has, and will add others to his line later.

THE AMERICAN ENGINE COMPANY, Bound Brook, N. J., has just received an order from the Hollingsworth & Whitney Company, Waterville, Maine, for the entire engine equipment of its new mill, consisting of two special 300-h.p. double engines and a 125-h.p. engine, and also a complete 75-k.w. electric generating plant.

THE E. P. ALLIS COMPANY, Milwaukee, has made another large sale of Allis-Corliss engines for use in Great Britain. Six engines aggregating 15,000 h. p. have been ordered for the Municipal system of street railways in Glasgow, Scotland. These engines will be coupled to generators built by the General Electric Company.

THE NEW EXCELSIOR DRY BATTERY COMPANY has removed from Mount Vernon, N. Y., to 661-663 Hudson Street, New York City, which location is better adapted to the receipt of raw materials, the finding of suitable labor and the prompt shipment of goods. The change will enable the company to more promptly meet hurry orders.

W. T. PRINGLE & CO., Philadelphia, are now well equipped to turn out switches, switchboards and panel boards, for which they have already established a reputation. Their switches and switchboards meet with the approval of the fire underwriters, and Mr. Pringle announces that he has a large stock on hand ready to supply immediate demands.

CHARLES WIRT & CO., Philadelphia, report that they are extremely busy, largely with dimmer orders. They announce a new interlocking arrangement for theater dimmers, intended to render the operation of these devices thoroughly certain, permitting of quick manipulation and particularly designed to avoid error or confusion even if operated in the dark.

THE BABCOCK & WILCOX COMPANY will, it is rumored, establish new and extensive works at Bergen Point, N. J., on the shore of the Kill-von-Kull. The purchase price of the land is said to be in the neighborhood of $300,000, and the cost of the buildings proposed for erection thereon $1,000,000, which buildings will give employment to more than 1,000 men.

THE GOLD CAR HEATING COMPANY and the Gold Street Car Heating Company, New York City, report that the number of orders which they have taken during the past few months are of such magnitude as to surpass all former records of the companies. Prominent among these orders is one from the Boston Elevated Railway Company, for electric heaters for its one hundred new cars.

MR. ELMER G. WILLYOUNG, New York City, states that all orders for Willyoung instruments and other electrical testing apparatus should be sent direct to him instead of to Messrs. Foote, Pierson & Co., who will simply manufacture Willyoung apparatus as noted in the last issue of the American Electrician. While to all intents and purposes Messrs. Foote, Pierson & Co. and Mr. Willyoung are one concern, the former will be manufacturers for the latter and the latter will be the designer and seller for the former.

A NEW ELECTRICAL MANUFACTURING COMPANY.—The Scott-Janney Electric Company, Philadelphia, was recently incorporated at Trenton, N. J., with a capital of $30,000,000, and, it is stated, will erect a large plant in Philadelphia at once. Among the incorporators are Mr. Gordon J. Scott, Mr. W. S. Janney and others in the past interested in the old Scott & Janney Electric Manufacturing Company. The new company will make a general line of apparatus in competition with the Westinghouse and General Electric Companies.

EDWARD S. HALSEY, 88 State Street, Chicago, Ill., announces that he is just about ready to fill orders for the maximum recording attachment for integrating meters, which attachment was recently described in these columns. In addition to this device, which already promises to meet with quite a demand, Mr. Halsey is at work on others, one a direct current motor meter without a commutator, described in the August issue of the American Electrician, and another, a disappearing figure recording dial. For the latter there should be a great demand, as recording dials of the type now commonly used are practically unreadable to the layman, while with disappearing figure mechanisms, such as are used in cyclometers, no one who can read figures can make a mistake. Mr. Halsey now has ready for distribution a circular describing the construction and advantages of the maximum recording attachment mentioned above.

CORRESPONDENCE SCHOOL TEXT BOOKS.—The question has been raised in educational circles whether the modern and practical methods of instruction used in correspondence schools will not soon bring about decided changes in the same direction in the methods of the institutions of technical learning, and make necessary a complete revision of most of the text books now in use. The ordinary text book takes a great deal for granted and leaves the elaborate discussion of difficult points for the teacher to explain. The correspondence school, having no teacher at the pupil's elbow to fill in the long explanations, prepares text books with the idea of making everything clear and plain to the student at first sight. The text books on all the subjects taught in The United Correspondence Schools, New York City, are written with constant attention to this point. Years have been spent in their preparation and revision. Then, again, each phenomenon explained is brought forcibly home to the practical man by the mention of its practical bearing so that he constantly recognizes in the text answers to questions that have often puzzled him. This maintains his interest much more than does the development of an elaborate theory apparently unrelated to his business or professional work. The great usefulness of these clear and concise works of The United Correspondence Schools has been more fully demonstrated, perhaps, in the electrical engineering courses than in any other department of the schools. Results have been obtained and are constantly being obtained with students in these schools which must be attributed largely to the wonderful clearness and accuracy of the text books in use, which give the pupil minimum chance to obtain mistaken ideas. The Institute for Home Study of Engineering and the Correspondence School of Technology of Cleveland were recently bought outright and incorporated with The United Correspondence Schools, and their pupils now receive the benefit of the latter school's text books.

THE WESTERN ELECTRICAL SUPPLY COMPANY, St. Louis, Mo., is just putting on the market its latest improved 1900 phone,


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which has many new and novel features, among which is its transmitter, which is entirely moisture and damp-proof. It is claimed that this transmitter will out-talk any on the market, and cannot pack. The transmitter proper can be removed and replaced in a moment. The telephone department of the company has issued a pamphlet, describing some of the latest things in this line and entitled "A few ringers."

MURPHY AUTOMATIC SMOKELESS FURNACES are being installed under 5,000 h. p. of B. & W. water tube boilers in the Northwestern Elevated Railway power station, Chicago, making the fourth large power station of the "Yerkes" system having the boilers equipped with these furnaces by the Murphy Iron Works, Detroit, Mich. Murphy furnaces have also been sold to the extent of 1,600 h. p. to the Allegheny Company Light & Power Company, Pittsburg, making the third order and a total of twenty furnaces for that power station.

THE BULLOCK ELECTRIC MANUFACTURING COMPANY, Cincinnati, Ohio, has received so many English orders recently that it has necessitated the sending of Mr. B. W. Spellmire, the company's engineer of tests, to the London headquarters of the company. Mr. Spellmire will superintend the installation of Bullock machines in the territory mentioned, the first installation being in the large printing establishments of Cassell & Co., London; the Nottingham Guardian, Nottingham; Birmingham Daily Post, Birmingham; Manchester Evening Chronicle, Manchester, and the Belfast Evening News, Belfast.

THE BABCOCK & WILCOX COMPANY has sold to the Manhattan Elevated Railway Company, New York City, the boilers required for its new electric generating plant, which will furnish electric current for operating its entire elevated railway system in New York City. The boiler equipment will consist of sixty-four 520 h.p. Babcock & Wilcox all wrought steel boilers, capable of carrying a working pressure of 200 lbs. per square inch. The boilers will be fitted with Roney automatic stokers, manufactured by Westinghouse, Church Kerr & Co. This is the largest single order ever placed for stationary boilers.

THE RIDGWAY DYNAMO & ENGINE COMPANY, Ridgway, Pa., has received recently, besides other business, orders for three 75-h.p. tandem compound McEwen engines direct connected to three 50-k.w. Thompson-Ryan generators, purchased by the Treasury Department for lighting the United States Court House and Post Office building at Cincinnati, O.; two 250-h.p. engines direct connected to two 150-k.w. generators for the Berwind-White Coal Mining Company, Philadelphia, Pa., for their mining operations at Windber, Pa. This will make a total of fourteen engines and ten generators of this make installed by these same people at Windber, Pa., within the last two years.

SPANISH-AMERICAN WAR PANORAMA AND GREATER AMERICA is one of the war books which is likely to be in continuous demand. It is a panoramic record of the triumph of Yankee Doodle. The eagle flaps his wings on every page, and "Old Glory" waves around and above every scene. Prominent officers connected with the war are here portrayed, as well as many of the "men behind the guns." The album is 5½x8 inches, weighs 12 ounces, printed on finest coated paper. Mr. Warren J. Lynch, general passenger and ticket agent "Big Four Route," Cincinnati, O., will mail a copy to any address in the United States, Canada or Mexico, for 12 cents to cover postage and packing.

THE WESTERN ELECTRICAL SUPPLY COMPANY, St. Louis, Mo., general selling agent for the Adams-Bagnall enclosed arc lamps, is gratified over the recent lamp tests conducted by the electrical department of the Ohio State University. After a series of tests as to efficiency, mechanical construction, general design and adaptability, the company states that the Adams-Bagnall lamp showed itself to be ahead of all others, making the general average of 97.1% on a basis of 100 of desirable points. The remaining seven of those in competition showed as follows, 87%, 88.7%, 92.6%, 93.3%, 89%, 92% and 90.2%. These tests were conducted not only for scientific purposes, but it was the intention of the University to purchase quite a number of the lamps which proved themselves the best. The contract was awarded to the Adams-Bagnall lamp.

THE VALUE OF CLING-SURFACE.—One of the most valuable points relating to the use of belts is not often fully realized, or, at best, not emphasized: this is the fact that the more belt surface there is running in contact with the pulley the greater is the power that may be transmitted by the belt. In running a belt tight only about half of the pulley surface is in contact with the belt, while if a belt can be made to run slack without slipping it can be made to embrace a greater arc and more power may be carried. The Cling-Surface Manufacturing Company of Buffalo, N. Y., reports that it is adding scores of belts every week to the number already running slack through the use of Cling-Surface, and of the daily letters received acknowledging this, one from Alhambra, Cal., says "after thoroughly testing Cling-Surface I find that I can run with a slack belt and get more power by far than I could with a tight belt before using Cling-Surface."

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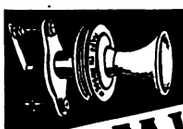

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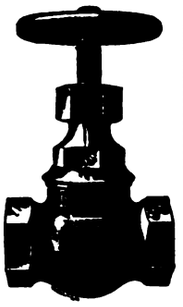


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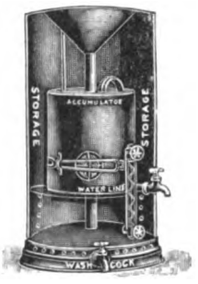
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fuel economizer, have recently received the following orders: For the Hollingsworth & Whitney Company, Waterville, Me., two large economizers, two induced draft fans with 14 ft. wheels direct connected to engines, together with about 150,000 pounds of steel smoke breechings, dampers, stacks, etc; Lukens Iron & Steel Company, Coatesville, Pa., two economizers, two induced draft fans with 12 ft. wheels and direct connected engines, also about 80,000 pounds of smoke breechings, dampers and connections; Weston Electrical Instrument Company, Newark, N. J., for the power house of its new works at Waverly, two economizers with metallic casing, connections, etc.; Vacuum Oil Company, Rochester, N. Y., third order, one economizer for utilizing waste heat from oil stills; Monterey Electric Light Company, Monterey, Mexico, one economizer complete with metallic casing, induced draft fans, etc. The York Light, Heat & Power Company, York, Pa., has closed a contract with Broomell, Schmidt & Co., Ltd., for two 250 h. p. American water tube boilers, complete with induced draft fans, settings, etc.

THE MICHIGAN ELECTRIC COMPANY, Detroit, Mich., reports that it has so far this year been crowded with work to its utmost capacity. Besides the ordinary small work, some interesting orders were as follows: For the City Hall in Detroit this company was given the contract to place permanent decorative lighting (including over 1,000 incandescent lights), and for the front of the City Hall a permanent adjustable metal frame for supporting electric signs, to welcome the different conventions (numbering over fifty) which are scheduled to meet in Detroit this year. This contract includes the furnishing of about 150 two, three and four foot metal illuminated letters for this use. There have already been in place fifteen or twenty of these convention signs, including a special "C. E." about 15 feet in diameter and weighing over a ton, which was used at the time of the Christian Endeavor convention. The company was also given a contract for furnishing and installing all electric work at the Christian Endeavor grounds (covering three city squares) which lighting included 70 arc and nearly 1,000 incandescent lights. The company now has in hand the exclusive contract for all electrical work at the Elks' Street Fair and Midway Exhibition to be given in Detroit from August 21st to September 2d, inclusive, for which there will be required 2,000 or more incandescent lights, 40 or 50 arcs, and probably several searchlights, as well as an electric fountain. This decorative lighting for the Elks' Fair will be one of the handsomest exhibitions of this class of lighting, for a two weeks' exhibition, that the country has ever seen.

ELECTRICAL NOVELTIES of the dry battery and miniature lamp order from the scarf pin of the last generation to a walking cane with a lamp concealed in its head for finding keyholes and similar purposes are generally considered unreliable toys not worthy the consideration of the engineer. That such a prominent concern as the Western Electric Company has taken up the manufacture of such devices is an indication that the dry battery, the essential feature of such novelties, has been improved to a point where the devices become of real practical use. The battery used is that named by the company the "Ever Ready" dry battery, the cells of which are ingeniously arranged with contacts on their ends so that several cells may be slipped one after another into a cylindrical shell and make suitable contacts. The lamps used are also an improvement on previous devices of the same nature, obtaining a much higher economy which gives longer life and greater light with the same battery. A carbon filament is not used, the emissive material being of metal, and the lamps are very perfectly exhausted in order to obtain a small convection of heat across the short space between the filament and the bulb. The novelties include surgical and dental lamps, bicycle lamps, night lights, electric candles, etc., one of interest and value being an electric gas lighter, in which the battery raises to a high temperature a platinum gauze which lights the gas in place of the spark and magneto commonly used. This gas lighter may be fitted with a miniature lamp supplied by the same battery, by means of which the gas fixture may be found without fumbling around in the dark.


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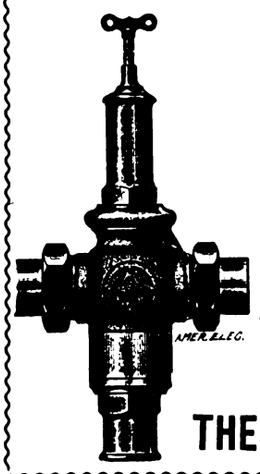
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# American Electrician.

Vol. XI. New York, October, 1899. No. 10.

# THE DOUBLE-CURRENT GENERATORS AND POLYPHASE APPARATUS OF THE CHICAGO EDISON COMPANY.

**A Complete Equipment for the Simultaneous Generation of Alternating and Direct Currents in the Same Machines, or the Conversion of Direct to Alternating Currents for High-Tension Transmission Purposes and Reconversion.**

BY HOMER E. NIESZ.

When the Edison lighting companies found that the low tension of their direct-current systems of distribution limited the area which one station could supply and required for larger areas a number of stations with a poorer economy than that of the equivalent single generating plant, they accepted as a valuable ally their erstwhile enemy—the alternating-current system. The rapid development of polyphase apparatus and particularly of rotary converters opened up a line of possibilities in central station consolidation and electrical co-operation that live engineers were quick to grasp, when it had been demonstrated by a plucky few how great were the advantages of transmission and distribution by this new system. Among the first to advocate, and the pioneer to adopt the system of transmitting alternating three-phase currents at a high potential to a sub-station, changing the power through step-down transformers and rotary converters and distributing it by

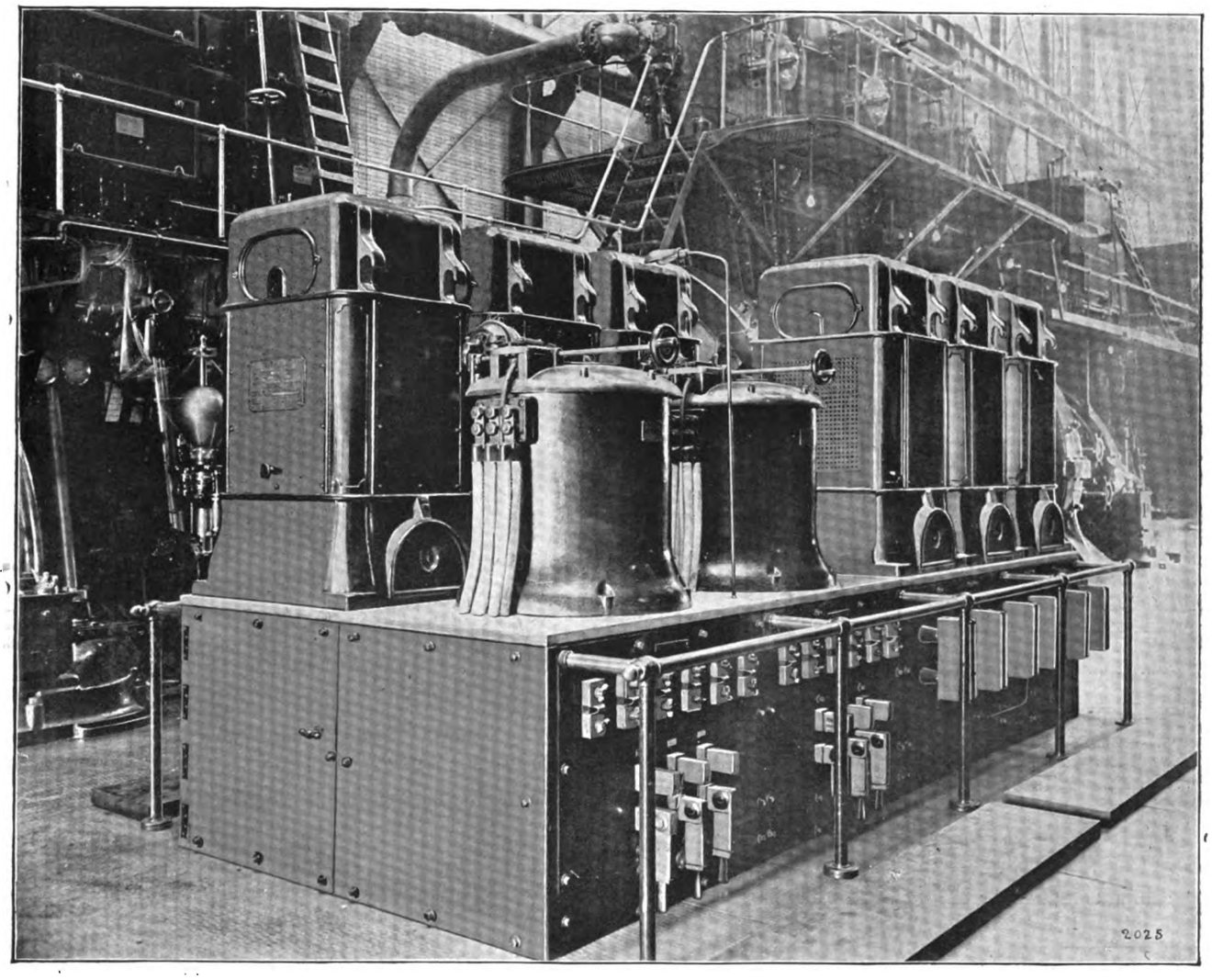



FIG. 1.—THE INDUCTION REGULATORS AND STEP-UP TRANSFORMERS FOR TWO DOUBLE-CURRENT GENERATING UNITS IN THE HARRISON STREET STATION OF THE CHICAGO EDISON COMPANY.

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means of a three-wire direct-current network, was the Chicago Edison Company, whose installation is the subject of this article.

Early in 1893 the possibility of such an installation was first seriously discussed and considered by the electrical engineer of the company, but it was then too early to put his ideas into execution, because the manufacturers had not yet developed suitable apparatus; and it was not until the spring of 1897 that the long cherished and strongly advocated plans were realized by the installation in the Harrison Street station of a 250-kw. converse rotary converter, that is, a machine absorbing direct and delivering alternating power. This rotary is driven by direct current taken from the + and — bus bars of the switchboard, though it was originally designed as a double-current belt driven generator, the first of its kind ever built.

From three collector rings at the end of the machine opposite the commutator three-phase currents are taken and conducted to air-blast transformers which raise the pressure to 4500 volts for transmission over 3½ miles of cable to a sub-station located at 27th Street and Wabash Avenue, where, by means of step-down transformers, the voltage is reduced and the power is transformed by means of two 100-kw. rotary converters into direct current feeding into the three-wire network of that district.

The success of this installation was so pronounced that it was immediately decided to enlarge it the following year. It then became expedient to build a double-current generator, so that the same unit could be used either on the direct-current downtown system or the three-phase transmission line independently or simultaneously. As the peak of the load on the 27th Street station occurred later in the day than that in the downtown district, the plan of building double-current generators was especially desirable, because by utilizing their capacity to carry at different times of day the peak load of both districts it obviated the necessity for separate machines for each peak, which would be required if two classes of generators were used. As a result, the first double-current direct coupled dynamos ever used for d. c. and a. c. lighting systems were manufactured and installed during the summer of 1898. A 600-h. p. engine already in use and direct connected to two 200-kw. direct-current dynamos was provided with an extended sub-base and outboard bearings, and a new armature and fields were put on, to provide the necessary frequency and collecting and commutating devices. During the present year an additional unit of the same size has been installed.

This in brief is a history of the installation, a description of which can be but general, as the details of the work are many.

In the plant at Harrison Street and the river there are two units, each consisting of a 600-h. p. Southwark vertical triple-

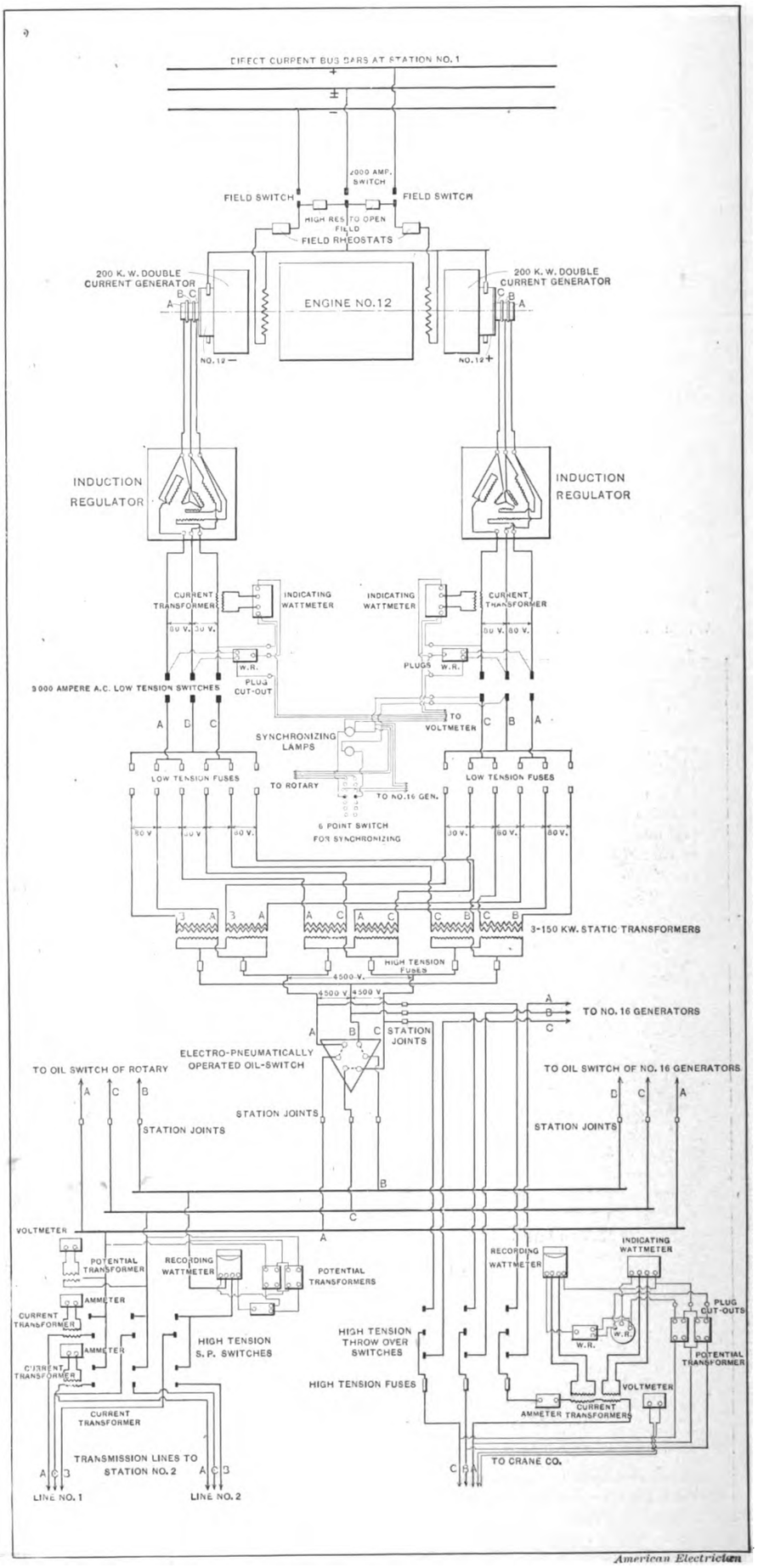



FIG. 2.—THE CIRCUITS FROM THE D. C. BUS BARS TO THE HIGH-TENSION TRANSMISSION LINES.

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FIG 3.—ONE OF THE INDUCTION REGULATORS SHOWING THE HAND GEAR, THE SMALL CONTROLLING MOTOR WITH ITS REVERSING SWITCH, THE FLEXIBLE LEADS TO THE MOVABLE SECONDARY AND THE DAMPER FOR CONTROLLING THE AIR BLAST.

expansion condensing engine direct connected to 200-kw. dynamos built by the General Electric Company, one at each end of the shaft. Each dynamo consists of a special single-wound armature, the coils of which terminate in a large commutator, about five feet in diameter and of ample cross section to carry the entire output of the dynamo in direct current. The brushes are of carbon of the radial type and are shifted and adjusted by means of a hand wheel, as is customary on large machines. A view of one of these machines is shown in Fig. 6.

The direct-current sides of these generators are connected in series to form a three-wire unit, supplying current through a standard d.c. low-tension panel on the switchboard in the gallery to the three-wire bus bars which furnish the bulk of the current for the downtown network.

Connected also to the armature windings are leads terminating in three heavy collecting rings, of smaller diameter than the commutator, and located practically within it, the commutator spider being cup-shaped and overhanging the collector rings. Bearing on each ring are twelve tangential copper brushes which carry off three-phase currents at about 80 volts pressure. There are 20 poles to each dynamo and the speed being 150 r.p.m., they give a frequency of 25 cycles, which is considered the best for transmission and power work.

The complete circuits from the direct-current bus bars to the high-tension transmission lines are shown in Fig. 2. From the collector rings of each dynamo, as this figure shows, the three-phase currents are conducted through six 750,000-c.m. asbestos covered cables to an induction regulator in order to give a control of the alternating-current pressure without varying the field strength, which must necessarily be adjusted to give the proper direct-current voltages. By means of the regulators the voltage may be raised 7½ per cent. or lowered 7½ per cent., giving a total range of 15 per cent. of the initial voltage. Each regulator is of 15-kw. capacity and is air cooled by forced draft. As is well known, these regulators, which are of the General Electric Company's I. R. T. type, have no moving contacts but are adjusted by moving an iron core which varies the inductive effect of a shunt winding upon a series coil. This core may be moved by hand, but for convenience in operating from a distance, there is installed a small three-phase induction motor to drive the core by a worm gear and this is controlled from the switchboard as described below.

From the regulator the current passes to three single-pole switches by means of which the two machines on one engine may be thrown together on the a. c. end or disconnected from each other or from the line. From the switches the current passes to six fuse blocks, which form the terminals of the low-pressure windings of the three 150-kw. air-blast transformers. Each leg of the three-phase circuit forks to two fuse blocks, thus giving each of the three low-tension transformer windings, which are delta connected, a fuse of its own at each of its terminals, so that if one transformer goes out the other two will remain working, as they would not if there were only three fuses, one in each leg. Each transformer is provided with two independent low-pressure windings, which magnetize the core. By this method one set of transformers can be used for the two dynamos comprising one unit without making electrical connection between the windings of the two generators. As the two generators are electrically connected in series with each other on their direct-current sides, any electrical connection on their alternating-current sides would of course become a very complicated short circuit.

There are two high-pressure windings in each transformer which can be connected either in multiple or in series, giving a potential of 4500 or 9000 volts. At present 4500 volts pressure is used. The high pressure leads of these transformers terminate in six high-pressure fuse blocks of a special design, known as the expulsion-type fuse blocks. The leads are brought through the panel board encased in hard rubber bushings, the current being carried from them through flexible connections to two hinged terminals which are pulled apart by springs. The fuse of stamped metal passes through two lignum vitae blocks, provided with air chamber and vent hole on one side, and is fastened at each end to these hinged terminals. The fuse being in a state of tension is pulled apart before it quite reaches the melting point and is withdrawn from the air chamber, so that only a very small amount of the metal is volatilized and the violence of the dis-

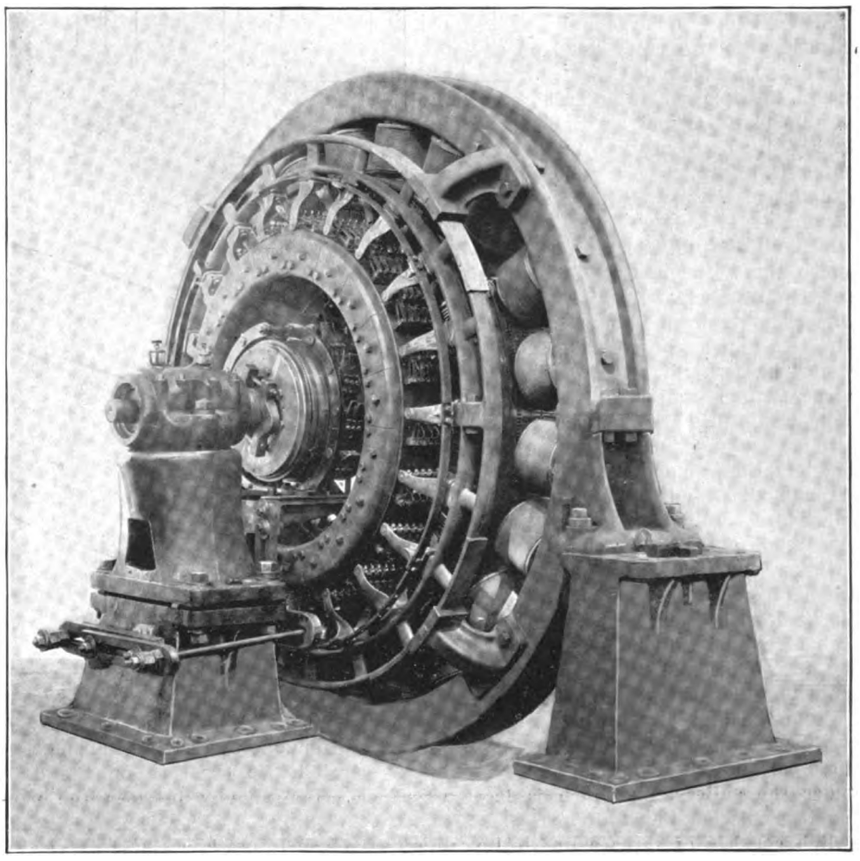


FIG. 4.—ONE OF THE DOUBLE CURRENT GENERATORS ERECTED IN THE SHOPS FOR TESTING, SHOWING THE COLLECTOR RINGS SUNK WITHIN THE COMMUTATOR SPIDER.

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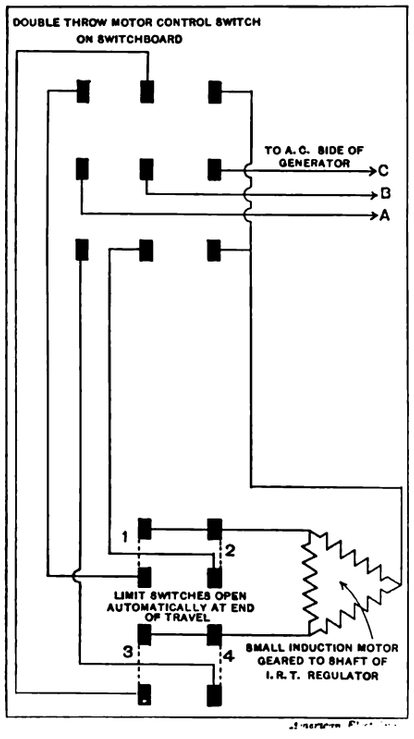



FIG. 5.—THE CIRCUITS OF THE CONTROLLING MOTOR OF AN INDUCTION REGULATOR, SHOWING THE METHOD OF REVERSAL AND THE ARRANGEMENT OF THE LIMIT SWITCHES.

ruption under high voltage and heavy load is therefore greatly reduced.

The six transformers and four induction regulators of the four dynamos constituting the two units stand on a platform in the middle of the floor space, between the two generator units. A view of this platform and apparatus is given in Fig. 1. There are two regulators and three transformers for each unit. Under the platform and enclosed by sides of marble is a large air chamber in which all the electrical connections between transformers, regulators and fuse panels are made. Air is forced into this chamber by a blower, driven by a direct-current motor, whose speed is controlled by a speed regulator, so that the proper volume and pressure of air may be maintained in the chamber. The transformers are provided with dampers which regulate the amount of air passing through them individually and may be adjusted according to the division of the load between them. On the sides of the chamber, mounted directly on the marble, are the high-pressure expulsion-type fuse blocks described above and the low-pressure fuses and switches, the former being away from and the latter facing the units to which they belong.

From the high-pressure fuses a three-conductor cable conveys the current to a three-pole switch of special type placed under the gallery, on which is located the transmission line switchboard. The switch consists of three cylindrical vessels filled with oil, in each of which one lead of the three-phase circuit is broken. The terminals and connections are arranged so that there are four breaks in series on each pole; each break being about four inches in length, which insures safe opening of circuit under any degree of load. The switch is operated pneumatically—the valves being controlled electrically from the operating panel—and can be locked open or closed by means of the special switch described below controlling them. Fig. 9 gives a view of the three switches of this type, one for each generating unit and one for the rotary converter.

The most interesting and important part of the entire installation is the regulating board, located in the switchboard gallery, a view of which is reproduced in Fig. 7. The direct-current panel for each unit is of the standard type used for three-wire direct-current central station work. The fields are bus-excited and the necessary regulation of the field strength is done by resistances controlled by parallel clip switches on the d. c. panels. Immediately between the panels controlling the d. c. side of the double-current generators is a single panel containing all the a. c. regulating and controlling devices for the two units or four three-phase generators. At the top of the panel are four indicating wattmeters, showing the output in watts of each generator. Below these are the phase lamps—two for each unit—which show when the units are in synchronism and ready to be thrown in multiple. Between the two sets of phase lamps is an a. c. voltmeter, and below it a double-pole multiple point switch, by means of which the voltmeter may be connected to any one of the generators. Below the voltmeter and switch are two three-pole double-throw knife switches—one for each generator—each of which controls the small three-phase motor mentioned above mounted on the induction regulator for raising or lowering the pressure. Below these are two multiple point switches—one for each unit—and connected to the phase lamps for that unit. There are also two special contact switches for operating the electro-pneumatic high-pressure oil switches. On the bottom of the panel are four single-pole knife switches, with high resistances connected across their terminals, for opening the field circuit of each generator.

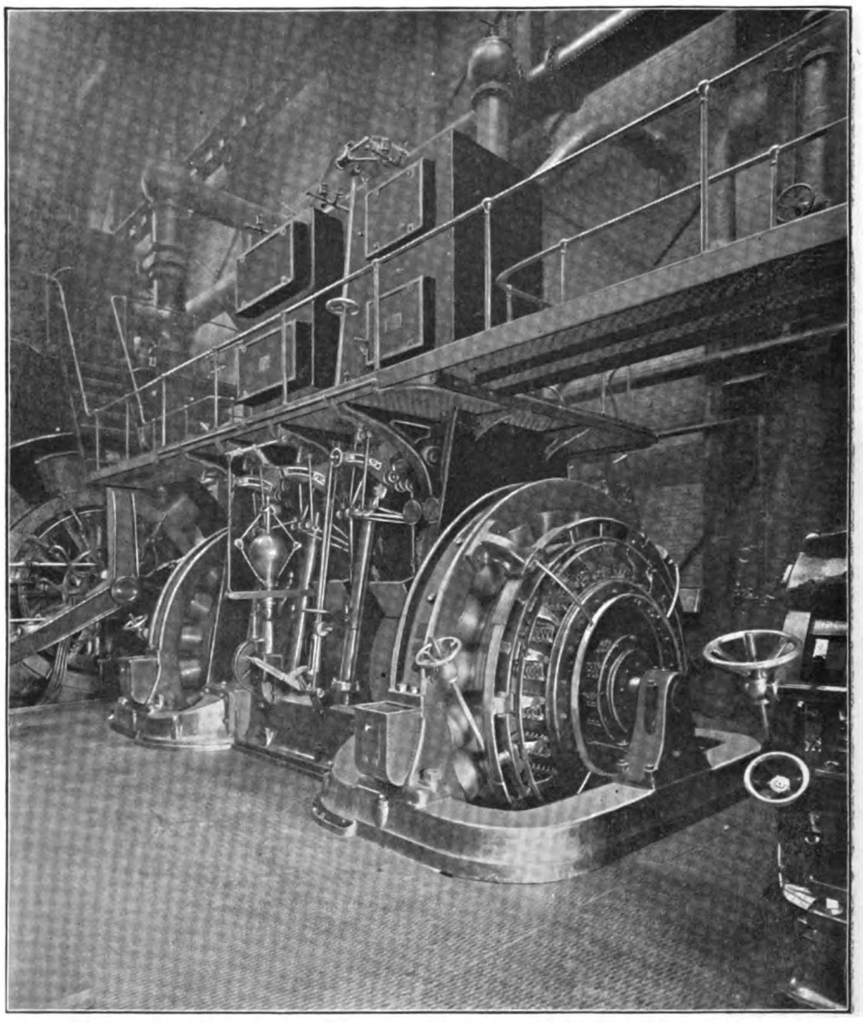


FIG. 6.—ONE OF THE DOUBLE-CURRENT GENERATING SETS COMPLETE IN THE STATION.

The controlling apparatus of the electro-pneumatic switches is shown diagrammatically in Fig. 8. The direct current

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enters the apparatus from the d. c. bus bars and passes under control of the hand switch in the upper part of the figure to one or more of the magnets, A, B, C, on the air cylinder. In the position, D, in which the switch is shown open, there is no circuit through any of the magnets. When the switch is rotated to the right it strikes a segment carrying current to magnet, A, which works an auxiliary air valve which operates the main valve, admitting compressed air to the upper end of the cylinder and opening the lower end to the atmosphere. The piston is by this means forced down, closing the switches attached to its cross head. A further movement to the right brings the switch arm in contact with a segment closing the circuit through magnet, B, which is a mechanical latch holding either valve A or C open, except when B is energized. A further movement to the right operates magnet C, admitting air below the piston and forcing it up, thereby opening the main oil break switch.

All the various functions of operation and regulation of these generators can be accomplished by the regular switchboard attendant from this panel on the gallery, and the entire installation is thus under his control, enabling it to be handled quickly, conveniently and economically. There are no leads to the a. c. panel carrying heavy currents or high pressures. The heavy current leads run directly from the generators to the transformer stand and are very short. The indicating wattmeters are connected by means of small secondary wires to series transformers inserted in one leg of the leads from each generator. On another panel are four a. c. ammeters connected to these same wires, which show the number of amperes generated, whether energy or wattless current, and indicate any cross current or hunting between generators.

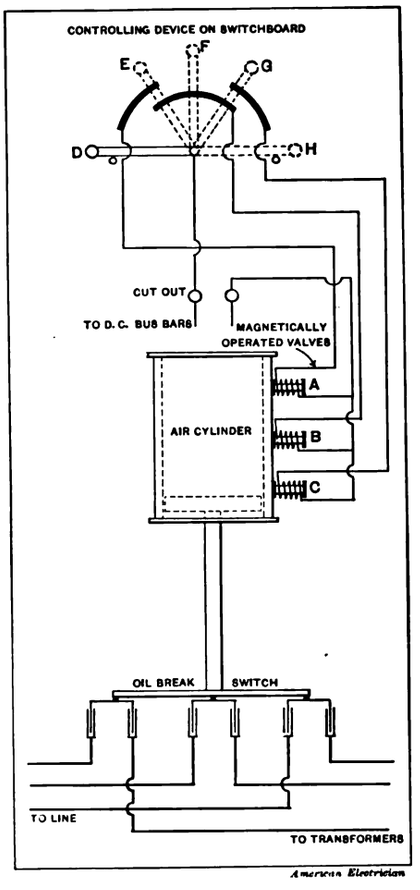
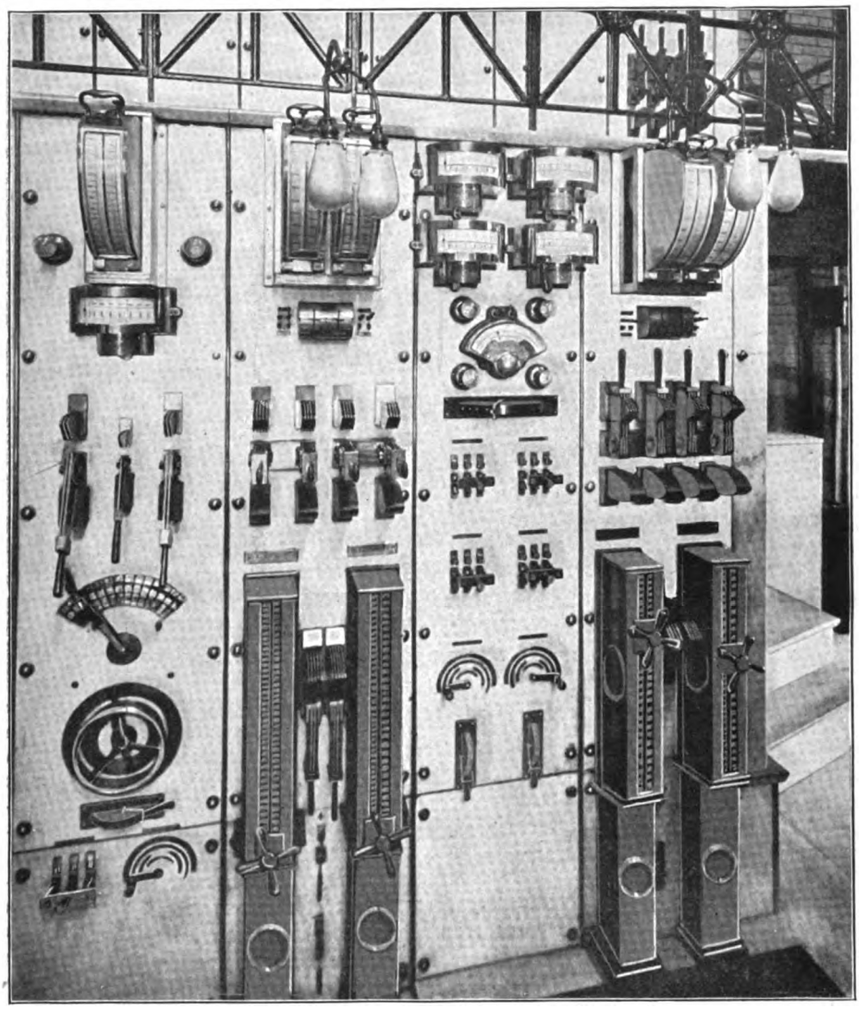



FIG. 8.—THE CIRCUITS OF THE CONTROLLING DEVICE OF AN ELECTRO-PNEUMATIC SWITCH, SHOWING THE METHOD OF OPERATING THE VALVE MAGNETS AND INTERLOCKING THEM.



| PANEL FOR BOTH SIDES OF ROTARY. | D. C. PANEL OF UNIT No. 14. | A. C. PANEL OF BOTH UNITS. | D. C. PANEL OF UNIT No 16. |
|---|---|---|---|
| D. c ammeter.<br>Synchronizing lamps.<br>A. c. ammeter.<br>Switch around starting box. Field switch.<br>Switch to starting box.<br>Starting box.<br>Field rheostat.<br>Synchronizing switch.<br>Switch of I. R. T. regulator. Controller of oil break switch. | Pilot lamps.<br>Ammeters.<br>Potential indicators for paralleling.<br>Main positive and negative switches to two sets of bus bars.<br>Parallel-clip field rheostats.<br>Main switches to neutral.<br>Field switches. | 4 a. c. ammeters.<br>Synchronizing lamps.<br>A. c. voltmeter.<br>Voltmeter switch.<br>Switches to 4 I. R. T. regulators.<br>Controllers of oil-break switches.<br>Synchronizing switches.<br>Left-hand side of panel for No 1; right-hand side for No. 16. | The equipment of this panel is similar to that two sections to the left.<br>This panel controls the d. c. end of the two generators comprising unit No. 16.<br>The a. c. controlling apparatus of the same machines is immediately adjacent to the left. |

FIG. 7.—THE SECTION OF THE MAIN SWITCHBOARD CONTROLLING BOTH THE DIRECT-CURRENT AND THE ALTERNATING-CURRENT SIDES OF THE ROTARY CONVERTER AND OF THE TWO DOUBLE-CURRENT THREE-WIRE GENERATING UNITS.

The phase lamps are connected through the double-pole multiple point switches above mentioned to one phase of the generator leads. Each unit has its own phase lamps and its own switch, by means of which it may be connected to the other unit or the converse rotary converter, without touching any other part of the panel than that containing the apparatus controlling that unit. By means of the multiple point switch below the voltmeter that instrument may also be connected in parallel with one of the phase lamps so that the needle will indicate simultaneously with the lamps when the generators are in step.

The three-pole double-throw knife switch for controlling the motor, which rotates by means of a worm gear the movable part in the induction regulator, is connected so that by throwing the switch up the motor will run in a certain direction and raise the pressure. By throwing the switch down the motor will be reversed and the pressure lowered. The circuits of this switch and the mo-

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tor are shown in Fig. 5. The three-phase current enters through the wires, A, B, C, to the hinges of the throw-over switch. Leg C goes right through to the small induction motor whether the switch is up or down. Legs A and B go through other switches located on the machine and numbered respectively in the diagram, 1, 2, 3 and 4. These are limit switches, which prevent the small induction motor from turning the regulator too far in case the switchboard attendant tries to raise or lower the voltage beyond the capabilities of the regulator. In case he leaves his switch in the upper position, switches 1 and 3 are opened automatically when the regulator reaches its highest boosting position, thus stopping the small induction motor, but it is obvious that this does not cut it out of circuit when the switchboard attendant throws his switch over to the downward position when circuit of legs A and B is made through switches 2 and 4. These, however, open when the regulator is depressing the voltage by its maximum amount, to prevent the motor from running too far in that direction. The extent of the arc through which the movable part of the induction regulator may be turned is thus limited automatically.

The convenience of this method of regulation of pressure is most marked and can be best appreciated after an attempt at hand regulation with the aid of an assistant on the floor. The two double-current units and the 250-kw. converse rotary, which is controlled similarly by devices on the panel adjacent to that for the large units, may be operated in multiple and transmit a total of 1050 kw. for power purposes.

The principal purpose of this installation is to furnish current for the sub-station at 27th Street and Wabash Avenue, to be distributed from that point by means of rotary converters to the three-wire network of that district. The line for the transmission of the three-phase current from the Harrison Street station to the 27th Street station consists of two three-conductor cables, laid in ducts the entire distance of 3½ miles. These cables are each No. 2/0 B. & S. gage, with paper insulation, designed for 20,000 volts pressure, and are encased in lead sheathing covered with jute. At each end of the line each cable terminates in three single-pole quick-break knife switches of special design, by means of which either cable may be disconnected from the line at will. These are mounted on a marble board with barriers of slate placed between them and are opened by a pole hook in the hands of the operator. On the board at the transmitting end is a wattmeter which records the entire electrical energy transmitted; and a voltmeter which indicates directly in volts the pressure on the transmission line, as well as two ammeters, one on each transmission cable. A view of this board is shown in Fig. 10, and its circuits are shown in the lower right-hand corner of Fig. 2.

At the receiving end of the line are the necessary apparatus and appliances for reducing the pressure, changing the current to direct and distributing it over the feeders of the three-wire network.

This installation cannot be described in detail in the space of this article, but in general consists of the following:

A high-tension switchboard with switches and fuses for each set of transformers; three sets of three 150-kw. air-blast transformers; five induction regulators; two 100-kw. 125-volt rotary converters; two 200-kw. 125-volt rotary converters; one 250-kw. 250-volt rotary converters; with the necessary low-tension switchboard for regulating and controlling both a. c. and d. c. sides of the rotaries.

There has just been installed a 4000-ampere-hour storage battery at an eight-hour rate in this station to carry part of the peak load and to furnish higher voltage current for some of the long feeders in remote sections of the districts.

Another important function of the double-current generators is the furnishing of three-phase current for power purposes in large factories. A line has been installed to the factory of the Crane Company, the well known makers of valves, in which are operated three-phase induction motors aggregating 200 h. p. The current is brought into the building at a pressure of 220 volts from a set of three 75-kw. transformers, which are mounted in a special transformer house built between two poles just outside the building, the line carrying 4500 volts being brought on poles from the station. Lightning arresters are placed on each end of the circuit. The special switchboard in the station from which the line receives the high-pressure current is shown in Fig. 11, and the arrangement of its details in the circuit is represented in Fig. 2. As will be seen from the latter figure, a tap is made on the transformer side of the oil switch of each of the double-current units, and three lead covered cables are carried to the Crane Company's board. One set of leads thus brought in is connected to the top and the other to the bottom terminals of three single-pole, double-throw, quick-break knife switches; the line being connected to the middle points, so that by throwing the switches

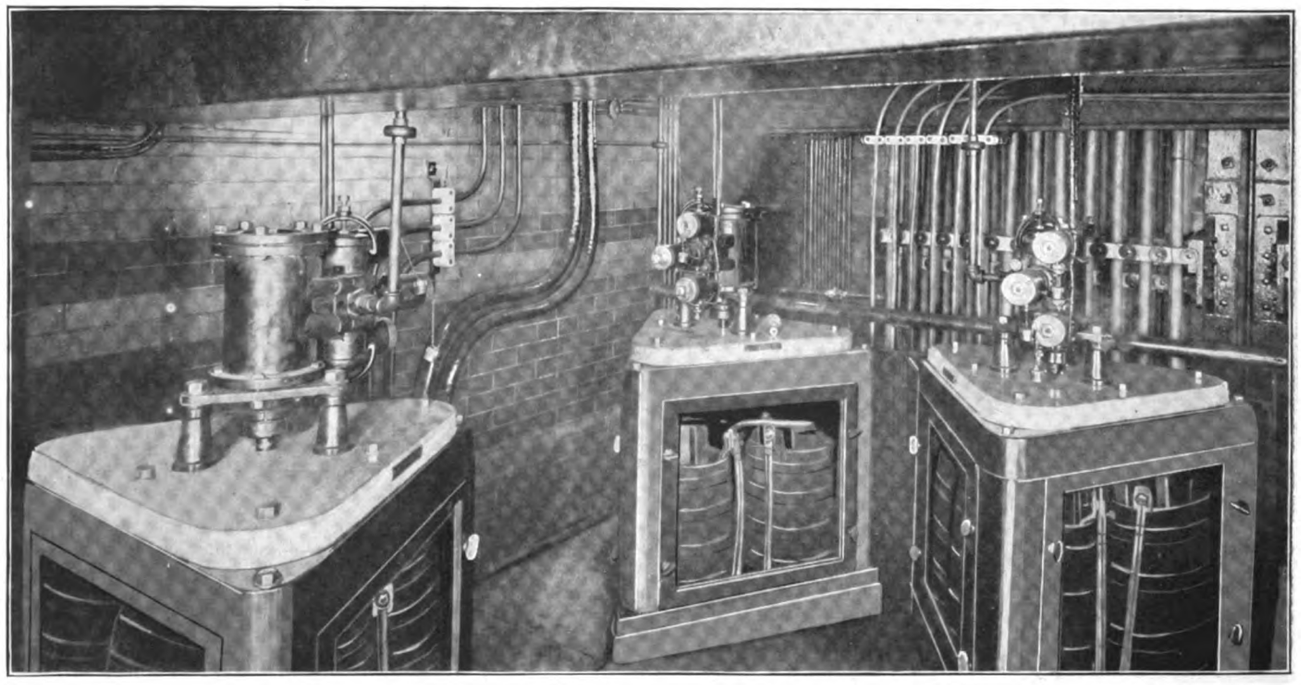


FIG. 9.—THE THREE ELECTRO-PNEUMATIC SWITCHES FOR THE TWO GENERATING UNITS AND THE ROTARY CONVERTER.

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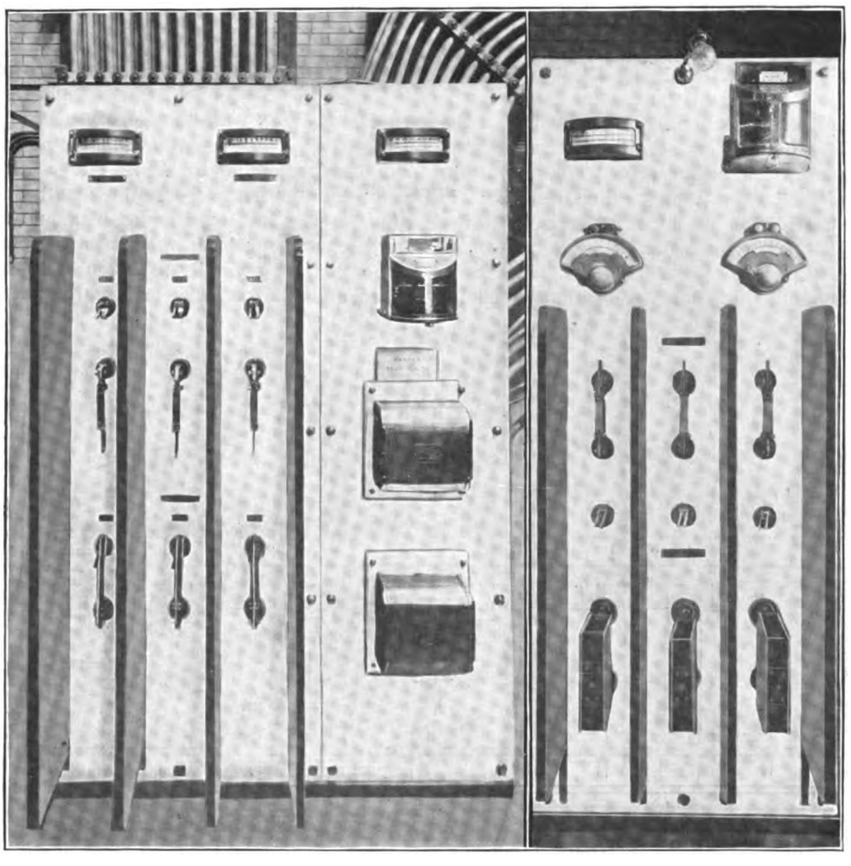


FIG. 10.—THE SWITCHBOARD OF THE TRANSMISSION LINES.

FIG. 11.—THE SWITCHBOARD OF THE POWER LINE.

up or down, the line may be thrown on either generator unit independently of whether either or both units are working singly or in parallel on the bus bars and transmission line.

The double-current machines in this station give an excellent opportunity for comparison with direct-current machines, since they stand immediately adjacent to three-wire sets of exactly the same output and exactly the same speed in revolutions per minute. In fact the first double-current unit is driven by an engine which originally drove direct-current machines and is a duplicate of other engines standing next to it and still driving such generators. The differences in appearance are as follows: A double-current machine necessarily has 20 poles to obtain the proper frequency, instead of the 6 poles on the direct-current machine, and in order to avoid crowding these poles the diameters of the yoke ring, the armature and the commutator have been increased and the machine has been shortened axially somewhat to compensate for this increased diameter. The narrower pole face necessarily reduces the number of slots and commutator segments per pole which can be used, which number in the double-current machines is 21, about ¼ of that in the older dynamos. This increases considerably the voltage generated per commutator segment, but proper commutation has been attained by using carbon brushes.

It will be seen that a great flexibility of operation is obtained by means of the apparatus above described. Each double-current generating unit can be used simultaneously to furnish current for the direct-current system, three-phase current for the transmission line and for the power line—either alone or in multiple with the other machines—and to the extent of its capacity on either the d. c. or a. c. side. The converse rotary may furnish current for the transmission line and one generator unit furnish current for the power line, independently of each other, or they may be run in multiple, or one generator unit may furnish current for both transmission and power line, or the second generator unit may be run in multiple with the converse rotary on the transmission line, independently of the generator unit on the power line, or all three may be run in multiple on the transmission and power lines—each generator furnishing direct current at the same time to the three-wire bus bars.

Thus the company is able to run its dynamos and engines at the point of greatest efficiency all the time and secure the best economy in operation with a smaller number of units, a more uniform system of apparatus and less investment in machinery.

The field thus opened up is capable of vast extensions and the realm of double-current generators for light and power business is almost limitless.

## THE ISOLATED PLANT OF A WHOLESALE GROCER'S ESTABLISHMENT.

Chicago is pre-eminently the city of large jobbing houses, among the most important of which are naturally those devoted to the collection, sale and distribution of the various food products raised largely in the adjoining States, shipped into Chicago, and there treated, prepared and sold for consumption to a large extent in the same districts. The running of a wholesale grocery involves more than the mere purchase and sale of food commodities, the raw material being to quite a large extent converted into more finished products. The processes require a large amount of labor which can be greatly economized by the use of many unusual types of machines, requiring the distribution of a considerable amount of power in small units. The peculiarity of this power distribution is the fact that the demand in any one department is quite intermittent. The baking-powder machines may be running one day and idle the balance of the week. The mince meat cutters have heavy duty in the fall of the year, and catsup kettle stirrers have their season of activity when tomatoes are ripe, etc. The result is a large amount of idle power-transmitting apparatus, which, if the transmission is mechanical, consumes a larger portion of the power generated than does transmitting apparatus with such a low load factor as that even of a machine shop.

A test of the equipment of the old house which the building described below supersedes, showed that some 65 per cent. of the power generated by the engine was wasted in the shafting and belting. This waste led to the equipment throughout of the building recently completed with electric power transmission. The structure is known as the Garrett Building and is a plain, but substantial, steel edifice built by the Northwestern University under special designs for the lessees, Messrs. Reid, Murdock & Company. The building is about 130x180 feet in size, ten stories high, with a basement, and is completely occupied by the wholesale grocery business of the above named firm. The first two floors are filled by the offices and shipping rooms, the upper three by the treating and manufacturing departments, and the others by warerooms of the materials kept in stock.

The isolated plant is an unusually complete one, and interesting, owing to the peculiar nature of the problems involved. The engine room contains three 75-kw. generators of a new type built by the Western Electric Company and containing some novel features, notably the protecting plates of the barrel wound end connections which are shown in Fig. 1. They are driven by two Erie Ball engines, and all engines and dynamos are in line and coupled together on the Arnold system. The general arrangement of the engines, generators and couplings on the shaft is shown by the plan, Fig. 2.

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and in greater detail by the sectional elevation, Fig. 1. Both the engines are horizontal tandem compounds with single valves, and designed for the same speed, 275 r.p.m. The one to the extreme left of the line is rated at 125 h. p., while the other has a capacity of 250 h. p.

As will be seen, the larger engine has a dynamo either side of the crank, there being two dynamos between the two engines, the smaller engine being at one end of the line. Normally the larger engine is coupled to the two dynamos adjacent to it, while the smaller engine is coupled only to the third dynamo next to it. Running through the hollow shafts of the two dynamos between the engines is a smaller solid shaft with flanges by means of which it can be coupled to either or both of the crank shafts of the two engines or to either or both of the flanges fixed to the hollow dynamo shafts surrounding it.

The arrangement of these parts is best shown in Fig. 1, in which the solid central shaft is shown in two sections, B and B', coupled together at the center by the ordinary flange coupling, N. In spite of the fact that this shaft is in two pieces it is supported only by the bearings, M and M', close to the central flange coupling, the greater part of the shaft and the discs on the end of it overhanging the bearings at either side. This condition exists, however, only when the shaft is lying idle in its bearings, for when the shaft is in operation it is supported at both ends as described hereafter. Surrounding this shaft are the hollow shafts or quills carrying the dynamo armatures. Each of these quills is supported in independent bearings, such as K and L, the latter of which is on the same pedestal with bearing M. The shaft, B, carries at its left hand end a disc, C, which runs between the flange, E, keyed to the crank shaft of the small engine and the flange, D, fastened to the generator quill. The flange, C, of the inside shaft can be bolted either to the engine flange, E, by means of taper bolts such as that shown at I, or to the generator flange, D, or the engine and generator flanges can be bolted together by means of bolts such as that shown at G, or all three flanges can be rigidly fastened together if both sets of bolts are in place as the drawing indicates them. Normally the inside solid shaft is loose at both ends and stationary, but it can be coupled up to throw either the right-hand dynamo upon the small engine, or the left-hand dynamo upon the large engine, or both generators upon either engine, or finally to fasten both engines and all dynamos rigidly together.

By this means the failure of any one dynamo does not incapacitate either engine, or does trouble with the smaller engine throw out of service any dynamo, while failure of the larger engine only shuts down the right-hand dynamo. The larger engine is made with cylinder dimensions sufficient to carry with two dynamos the whole load, and a reserve source of power is ingeniously provided without using any other engine of the same size, by fitting the smaller engine with a by-pass in such a way that both its cylinders can be used

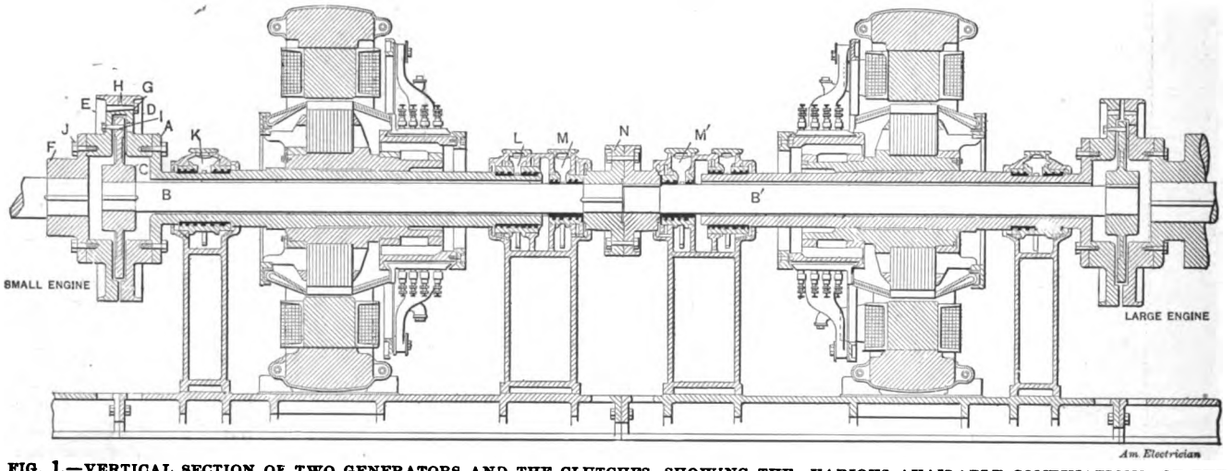



FIG. 1.—VERTICAL SECTION OF TWO GENERATORS AND THE CLUTCHES, SHOWING THE VARIOUS AVAILABLE COMBINATIONS OF THE ARNOLD SYSTEM.

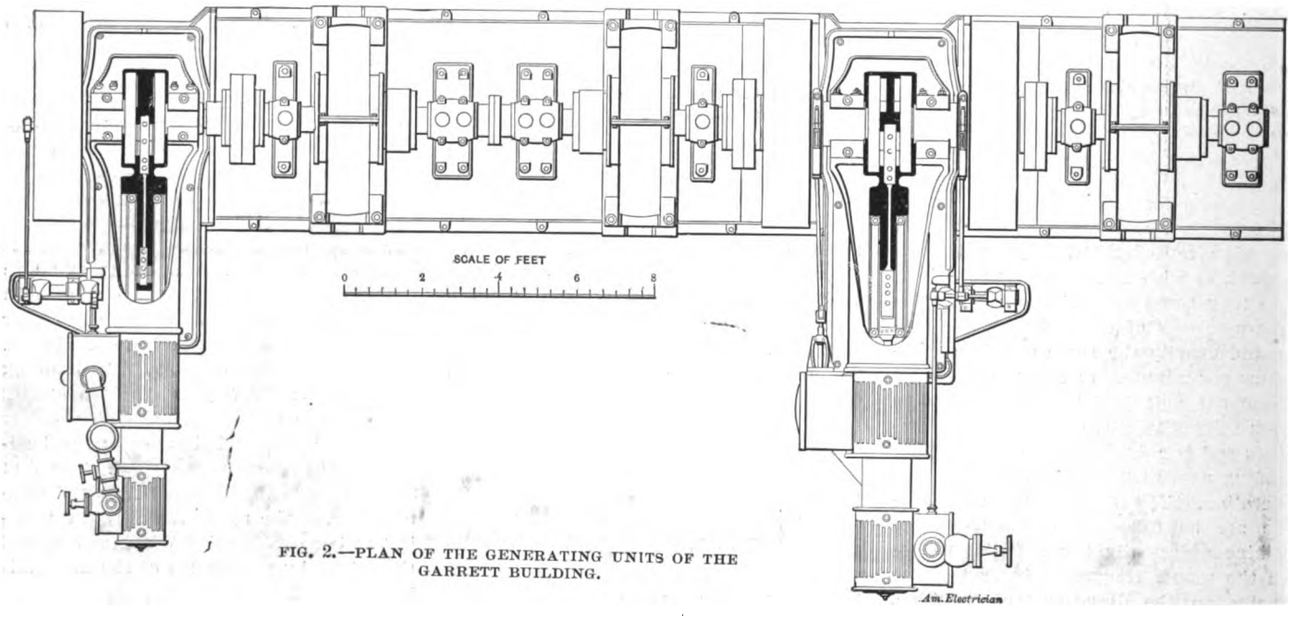



FIG. 2.—PLAN OF THE GENERATING UNITS OF THE GARRETT BUILDING.

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high pressure, under which condition it will deliver double its rated load, or fully that of the larger engine working compound.

Thus the central solid shaft is only used in case of emergency. This emergency might be the disabling of one of the generators or one of the engines. In case the large engine should break down it would be possible, by means of this interior shaft and the three-way couplings at its ends, to operate two of the generators from the small engine. This would be accomplished by bolting the disc, C, keyed on the end of shaft B, to the small engine flange, E. This connection would insure the revolving of the interior shaft, and by bolting the disc on the other end of the shaft to the generator flange, the small engine could be made to operate the generator which is not immediately adjacent to it. At the same time the flange, E, of the small engine could be bolted to flange, D, of the generator contiguous to it, and in this manner both generators would be operated by the small engine. By reversing the connection the large engine could be made to operate two generators upon one side and one generator upon the other; that is, by working under an overload of 50 per cent., the large engine can operate the entire plant, while the small engine is capable of handling two-thirds of the total generator capacity. As the total load of the plant never exceeds the output of two generators, it will be seen that the small engine is capable of handling the entire load in case of a break-down of the large engine, while, if any one of the generators or the small engine should be crippled, the large engine is in a position to supply the demand. Even the simultaneous break-down of the large engine and the right-hand generator, or

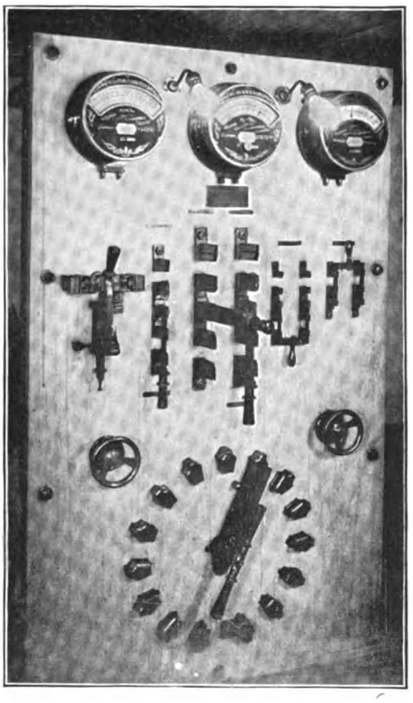


FIG. 3.—THE SWITCHBOARD CONTROLLING THE STORAGE BATTERY.

the small engine and any one generator would not reduce the capacity of the plant below the maximum demand.

To insure the same reliability with regular direct-connected units it would be necessary to install three engines and three generators. Thus one large engine is used in place of two smaller ones, giving better steam economy on large loads and yet a small engine is available for light loads. This arrangement, therefore, not only costs less for machinery, but gives a more compact plant, requires less steam piping and is more convenient to operate.

The bolted couplings are designed so that they may eventually be replaced by magnetic clutches, the latter not being installed, as the load is a reasonably steady one and capable of being carried temporarily by the storage battery while the generating plant is shut down for changing couplings.

The bearings, slides, etc., of the small engine have been prepared for this extra duty, the frame being that standard for 150 h. p., and its ability to perform this service has been proven by continuous operation under this load. Steam at full boiler pressure of 150 pounds is not admitted to the low pressure cylinder of the smaller engine, a reducing valve being inserted to hold the admission pressure of the low pressure cylinder down to about 60 pounds. The generators are supported on an iron sub-base extending between and bolted to the engine frames. The pedestals are supported on liners, and dowel pins, in addition to the ordinary bolts, have been inserted in order to maintain the accurate alignment necessary with such a large number of journals in line with each other. The generator frames are split vertically in order that they may be pulled apart and removed if necessary, without disturbing the double line of shafting running through them, thus allowing convenient access to the field and armature coils.

The plant is non-condensing, exhaust steam being used for heating purposes in the winter season.

The introduction of the storage battery and its use without a booster directly in parallel with the generators has involved some peculiarities in the switchboard arrangement. The main switchboard, which

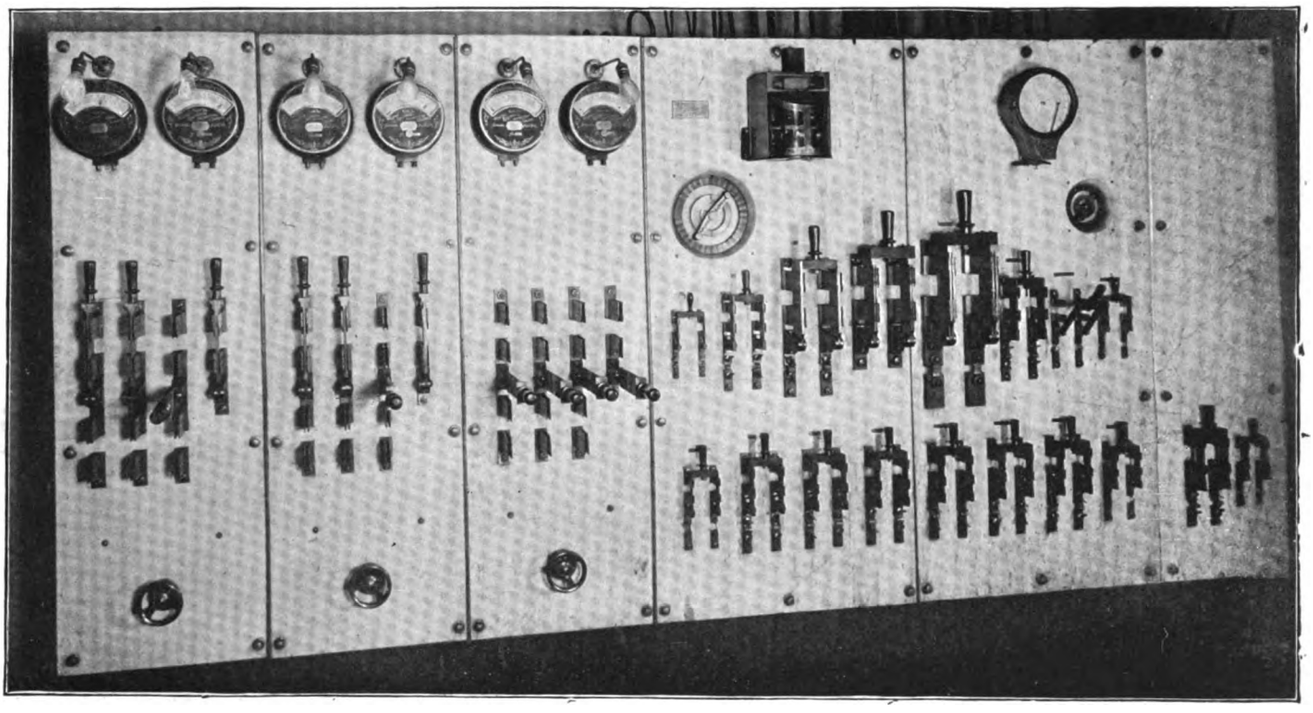


FIG. 4.—THE MAIN SWITCHBOARD, SHOWING UNIQUE ARRANGEMENT OF MAIN SWITCHES ON GENERATOR PANELS TO THE LEFT.

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does not contain the battery equipment, is shown in Fig. 4. The three panels to the left are devoted respectively to the three generators, and each contains, as may be seen, three single-pole, double-throw switches and one single-pole, single-throw switch. The purpose of these switches is to run the machines either shunt or compound on either the lighting or the power bus bars. The arrangement of these connections is shown in the left-hand side of the diagram, Fig. 5. Here it will be seen that the left-hand switch, A, when thrown up, connects the negative brush of the dynamo to the negative lighting bus, and when thrown down, to the negative power bus. The next switch to the right, B, performs the same function for the positive terminal of the machine. The switch, C, next to the right, is connected to the equalizer lead, that is, to the positive brush of the machine. In case this switch, C, is thrown in, the machine works as a plain shunt dynamo, whether the switch, B, to the left of it is closed or not. If the latter is also closed, the series field is short circuited, and if open, all current must pass direct via switch, C, from the brush to the bus bar without going through the series field. The single-throw switch, D, to the extreme right of the group, is an equalizer switch, used when running the machines compound. This is used when working upon either the lighting or the power bus, a separate equalizer for the two services being unnecessary, as there are only three dynamos, a number insufficient to give a pair for lighting and a pair for power. Thus with switch A and switch C up, the machine is operating as a straight shunt dynamo upon the lighting bus bars, and with switch A and switch B down, the machine would operate as a compound dynamo upon the power bus bars and could be thrown in parallel with another machine by closing the equalizer switch, D. This unusual equipment of switches is desirable in order to group the dynamos at times in parallel with the storage battery on the varying load due to the current taken by the elevators and stationary motors of the plant, when compound winding without a battery booster would make the distribution of the load unstable. At times when the battery is not in parallel with the machines they can be over-compounded as is usual in such plants.

Another novelty on the switchboard is the use of one integrating wattmeter with flexible cords and plugs by which it can be connected into any feeder. For this purpose there is cut into each feeder behind the board a removable copper strap with plug sockets above and below it, in which the wattmeter plugs can be inserted, the strap being then pulled out to throw the current through the meter.

The voltmeter is fitted with a Mabbs voltmeter switch by which it can be thrown to any machine, to the bus bars or to ground from either bus bar. One of the machine ammeters is also fitted with a Mabbs ammeter switch by which it can be thrown on to ammeter shunts respectively connected one in its own machine circuit and one in each feeder circuit. Thus this ammeter can be used whenever it is desirable to do so and at an instant's notice to measure the current on any feeder.

The battery consists of 115 cells of 15 F. chloride accumulators (the plant being throughout a two-wire 220-volt system). This size of battery was chosen on the principle that a storage battery for this service should have at an eight-hour discharge rate about one-third the ampere capacity of the generators. The cells are mounted in glass cases in sand trays on oil insulators, on racks two tiers high, in a special battery room.

The battery switchboard is a separate affair, shown in Fig. 3. Its circuits are indicated at the right hand side of Fig. 5. It is fitted with a 15-point end-cell switch operated by hand, in addition to which there is also installed a motor-driven booster. This booster is solely used for charging and is not differentially wound in order to render the battery capable of discharging in parallel with compound wound generators. The booster motor is supplied through a double-pole, double-throw switch, G, from either the lighting or power bus bars. Switch H throws the booster in series with the battery from either the light or the power bus bars, and switch, I, connects the negative end of the battery to either the power or the light bus when the booster is not used, while switch, J, is used when the battery is in operation either with or without the booster.

The generators normally run plain shunt in parallel with the load and the storage battery, the voltage of the latter being regulated by means of the end-cell switch. Occasionally they are run compound on the load, the battery being disconnected. Provisions are such, however, that the load can also be run on the machines either shunt or compound, the battery being at the same time charged through the booster, or the load can be put on the battery while the latter is connected with the machines through the booster.

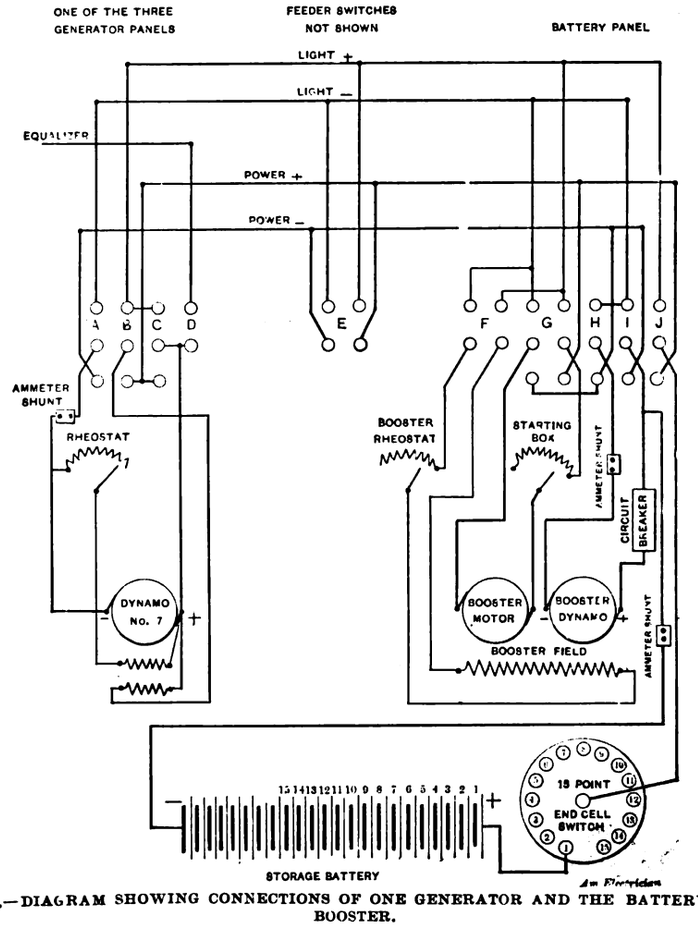
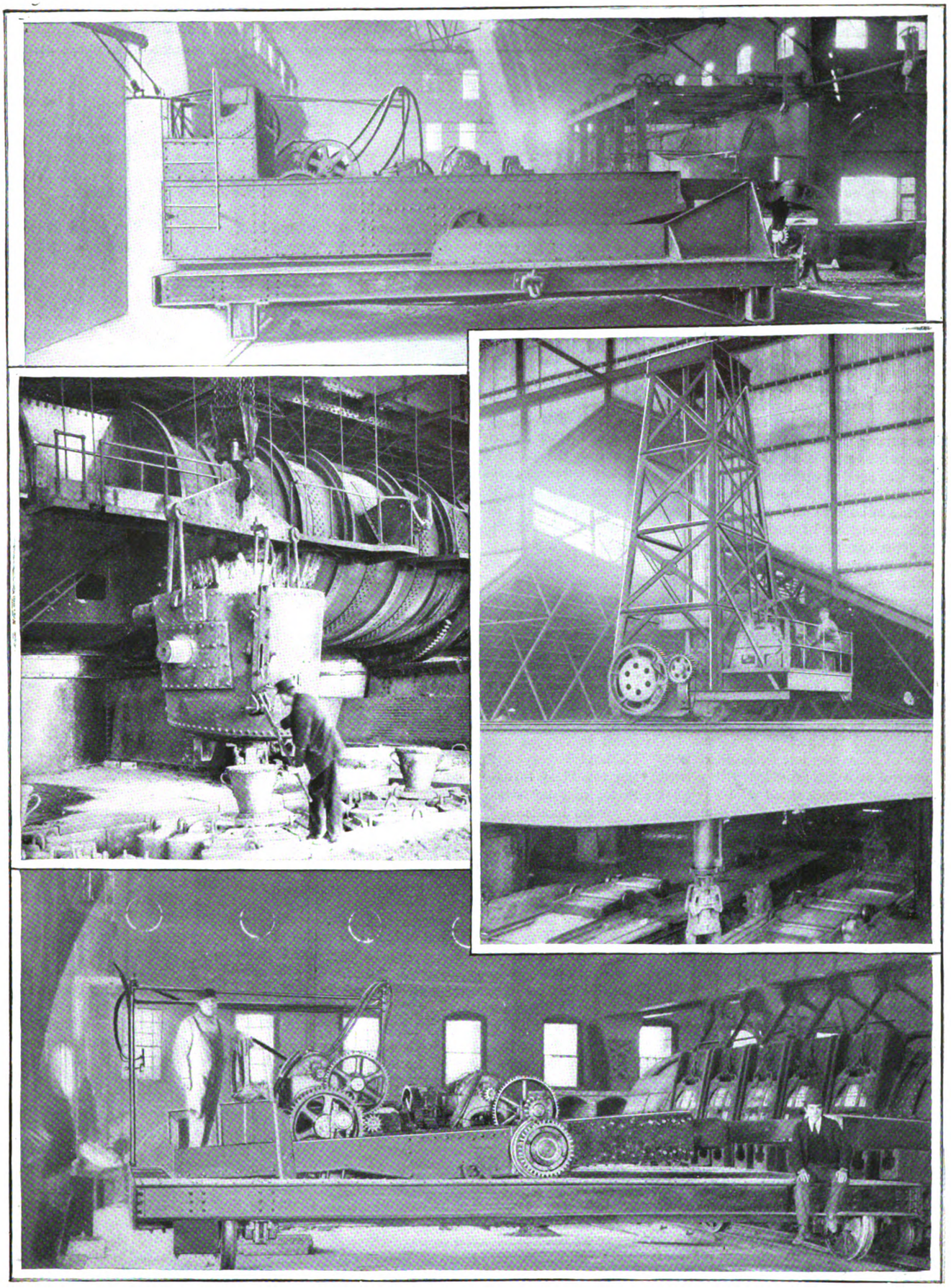



FIG. 5.—DIAGRAM SHOWING CONNECTIONS OF ONE GENERATOR AND THE BATTERY AND BOOSTER.

Throughout the building there are some 45 motors with an aggregate capacity of 350 h. p. all told, exclusive of the elevator motors. Of the latter there are 6, all Otis machines, 5 being rated at 25 h. p. each and one at 50 h. p., besides one dumb waiter. The large motor drives one 6000-pound freight machine at 250 feet per minute. The motors have all sorts of peculiar loads. In addition to those mentioned above there are carbonizers, bottling machines, raisin seeders, olive stoners, salad mixing machines, onion cutters, cucumber cutters, mustard pumps, centrifugal wringers, coffee conveyors, elevators

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An Electric Machine for Charging Ingots into Heating Furnaces in Plate Mill.
Pouring a Heat in the Open-Hearth with an Electric Crane. Electric Charging Crane over Rail-Mill Soaking Pits.
Electric Machine for charging Open Hearth Furnaces.

**Views of the Cranes and Charging Machines of the Illinois Steel Company.**—**For description see page 456.**

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and roasters, in addition to such ordinary loads as printing presses, etc. Of these motors about 40 were made by the Northern Electrical Manufacturing Company, and all of these are low speed, shunt wound and fitted with 15 per cent. speed regulation by means of field strength variation. All motors are controlled by Cutler-Hammer motor starters.

Down in the engine room are various motor-driven auxiliaries having an aggregate capacity of some 90 h. p. These motors drive the ice machinery, the air compressor for the pneumatic message system, the air fans for the indirect heating system and one air compressor for a pneumatic sewage ejector. The latter is entirely automatic in operation, the ejection of the sewage matter from the sump being automatically controlled by a float valve, and the compressor motor being in turn automatically controlled to maintain the air at 10 pounds per square inch by a Whittingham switch.

The wiring through the building presents several points of interest. The main feeders are carried up on porcelain knobs in a special feeder shaft, outside of which all wiring of current, telephone and signal service is carried in iron-armored conduit. This conduit differs from previous practice in being plain galvanized iron pipe of standard weight and unlined. The light and power wiring carried through it is double braided and covered with 1/32 inch more insulation than that customary in lined pipes.

The lighting throughout the building is entirely by means of 220-volt incandescent lamps, no arc lights whatever being used. The number of ceiling outlets throughout the warerooms is much greater than the number of necessary lamps, and each outlet, instead of being provided with a cord and socket, is simply fitted with a special receptacle. The men are given a number of cords and lamps fitted with attachment plugs which they can insert in these receptacles, thus keeping down the number of lamps connected but allowing the use of lamps in all desirable locations. The question of outlets on the office floors was a peculiarly difficult one in this building, as cords from overhead fixtures down to the desks were not wanted and the offices are in large rooms without provisions for getting at the desks from adjacent walls. No cords come down from the ceiling or electroliers in the two great office rooms which fill the first and second stories of the building, all lamps, telephones, annunciators, buzzers, bells, etc., being wired up through the floor. Under such desks as are fastened to the floor the conduit piping is brought up flush with the surface of the desk, a fixture bracket being screwed on above it, but with movable roll top desks this construction was not available. Pringle marine outlet boxes were used in this case for the telephone and signal wires, and Chapman receptacles in boxes with rubber gaskets for the lighting wires, these fixtures serving satisfactorily where they are located so as not to be trampled upon.

The telephone and signal service in these offices is worked out with unusual care. As is customary, a Bell private branch exchange is installed, but all of the 'phones wired to this exchange are not fitted for connection through over the trunk lines to the city system since a higher rate is charged for instruments so used than for those used only on private branch work. The private branch operators are therefore supplied with a call service with buzzers on the desks by which they can call any one wanted to the nearest long distance 'phone. The wires to these buzzers run in the same piping with the annunciator wires. The large number of lighting, telephone and signal conduits, annunciator and buzzer and special wires, with the compressed air message tubes and other pipes, gives under the second floor of the building an almost solid grillwork of iron piping.

The architects of the building were D. H. Burnham & Company, the work above described being under the supervision of the electrical and mechanical engineer of this company, Mr. Chas. M. Wilkes. The contract for the engines, generators, Arnold system, storage battery, booster, wiring and switchboard was given to the Arnold Electric Power Station Company, who sub-let the wiring and switchboard work to the Mutual Electric Company of Chicago.

# Electric Power as a Factor in Steel Mills.

It is gratifying to note the rapid development of electrical appliances for handling the metal in its various stages as it progresses through the different departments in some of the large steel mills of this country. Although electricity has been slow in entering this field, because of the very difficult problems to be solved, it is now getting a permanent hold and has given an opportunity for the display of engineering skill and inventive genius of the highest order to adapt it to the work in hand. Among the mills in which electricity has superseded direct steam power in a variety of distinct operations none are more interesting than the mills comprising the plant of the Illinois Steel Company at South Chicago, Illinois. This plant is located near the mouth of the Calumet River on the lake, and including the blast furnaces, covers about 450 acres, and in it are employed over six thousand hands.

The electrical devices are found mostly in the mills, as this power is not employed to any great extent about the blast furnaces except for lighting. In the open-hearth department motors aggregating 1200 horse power are employed, while about 600 motor horse power is found in the plate mill and the same amount in the slab mill. The application of motors in mills of this character is not, as many suppose, confined to travelling cranes merely, for while these are used both for handling the ladles and shifting materials, numerous other electrical machines are employed. Some are known as charging cars, others as ingot lifts, while in the slab mill the tables are shifted by motors, and there are motor-driven transfer tables for giving direction to the billets. Last, and most interesting of all, magnetic lifts and trolleys are employed in and about the plate mills.

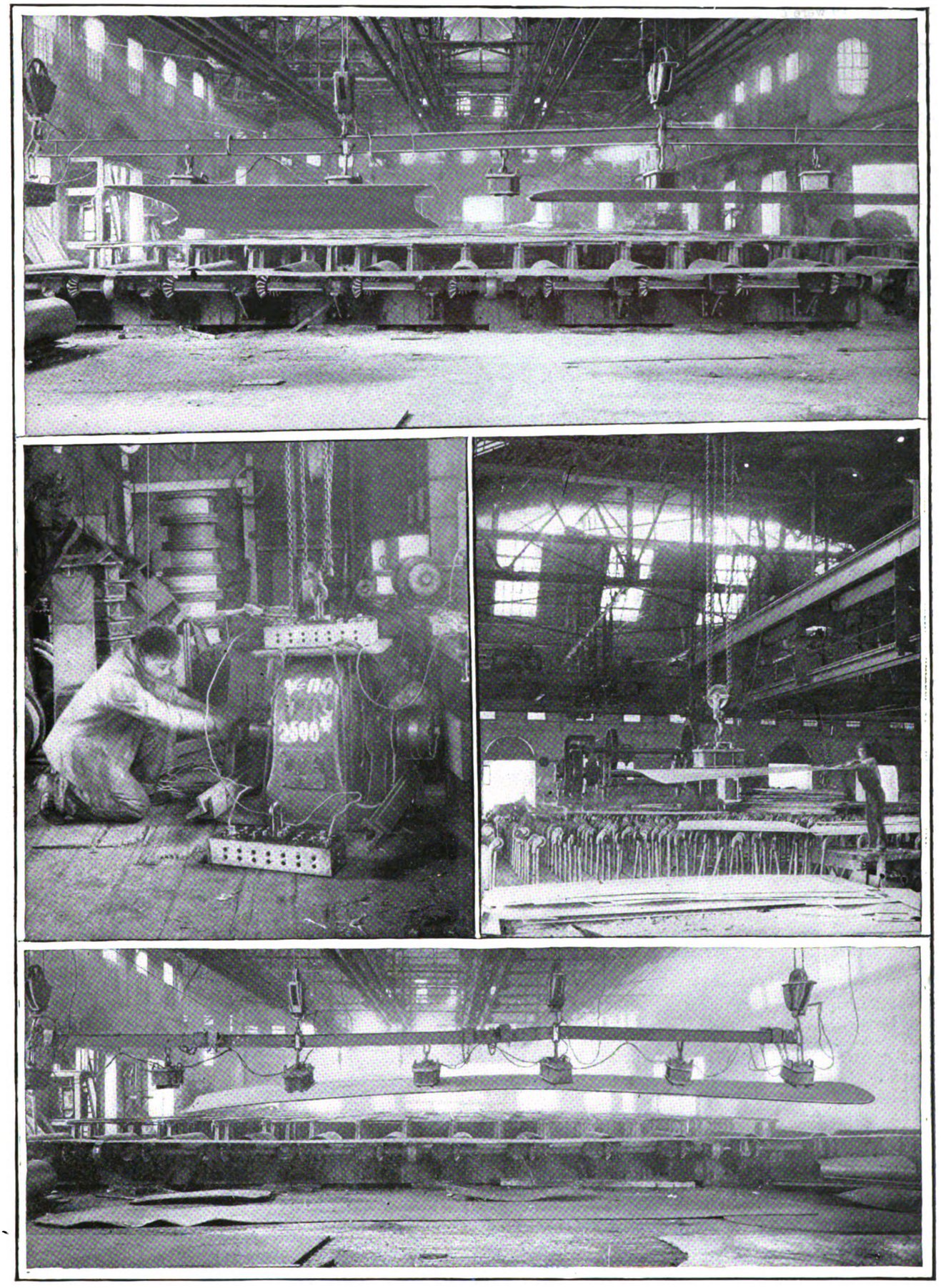
The largest of the travelling cranes are found in the open-hearth furnace department, and here are four of 75-ton capacity each, which are employed for handling the ladles. Four of the furnaces are of the revolving type, and when a charge is ready for pouring, the ladle is brought into position by the crane. The furnace is revolved or tilted by means of a pair of hydraulic cylinders. The ladles are supported from the crane by stirrups and are filled to overflowing with the molten metal in order to remove the slag, which floats on the steel while both are molten. When ready, the crane swings the ladle into position over the ingot moulds, when the metal is allowed to flow into a funnel-shaped receptacle known as the fountain, which connects with the base of the four moulds so that the four are filled from the bottom simultaneously. Great accuracy is required in handling and adjusting the ladles, but electric power is found to meet the most exacting requirement. One of these ladles is shown in service on page 455.

The large cranes have each two traveling hoists, the small one being of 20-ton capacity, which is employed for turning the ladles when it becomes necessary to empty them of the surplus metal or slag. These lighter hoists are also employed for lifting light weights. The large cranes are each equipped with seven motors; two of these are connected in parallel for operating the main hoist, two similarly for the auxiliary hoists, and the others operate the two trolley travels and the bridge travel. In the same department are two other electric traveling cranes of thirty tons capacity each, which are operated for the lighter work, and there is also a 40-ton crane with which an auxiliary lift is also provided for handling the smaller ladles. A third 75-ton crane is about to be installed in which the engineer proposes to use wire ropes in place of the chains for the hoists, and for this purpose large sheaves will be employed. This change is made for the reason that it is difficult to forge large chains so that the links shall all have a proper factor of safety.

Passing to an elevated platform in the rear of the revolving and open furnaces, we find two charging cars which are employed for introducing the metal into the furnaces.

These charging cars, which are illustra-

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Electro-magnets Carrying Plates from the Rolls to the Shears.

Testing an Electro-magnet—Weight, 120 Lbs.; Load, 3 000 Lbs.; Current, 2½ Amperes at 110 Volts.

An Electro-magnet Suspended on the Hook of an Electric Crane for Handling Sheared Plates.

Electro-magnets Carrying One Long Plate.

**Views of the Lifting Magnets of the Illinois Steel Company.**

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ted on page 455, resemble the battering rams employed by the ancients. They are longest across the track on which they run, and the arm or ram has several movements; one tilts it up and down, another revolves it half way over on its axis, and tne third gives it an advance and retreat motion. All these movements are under the control of the operator, who stands on the off side of the car from the furnace and manipulates the levers that start the motors. The metal for the charge is cut by shears into suitable lengths and is packed in cast-iron pans or boxes of oval shape and about four feet in length and twenty inches wide and deep. These are brought in and placed on suitable racks along the face of the furnaces. Each charging box has a dovetailed shaped chamber at one end into which the end of the ram drops and it is locked in position. The box is then lifted and the car moves with it to the mouth of the furnace when the ram is extended, and as soon as the charge is well within the fire chamber the box is inverted and its contents dumped into the molten mass. The box is then righted, withdrawn and placed back upon its rack, when another is picked up and the operation repeated. The work of charging is done without exposing the operators to the excessive heat. Machines of the same type are also employed in the rail mill and one of the other mills for charging and drawing the blooms from the re-heating furnaces preparatory to rolling.

Above a platform, adjoining that on which the charging cars operate, is an ordinary electric traveling train for loading and handling the dolomite, which is crushed and employed for the floor and lining of the open-hearth furnaces.

In the plate mill electro-magnets, illustrated on page 457, are employed for lifting the plates. These are cheaper, safer, quicker to operate and are more efficient than chains and hooks. The largest lift is composed of seven magnets, which are attached by chains to a long beam, which, in turn, is suspended by wire ropes from overhead traveling trolleys, and these are propelled along the run by a motor-driven drum. This set of magnets is capable of picking up plates weighing ten thousand pounds and transporting them to any desired distance and dropping them in convenient proximity to the plate shears. Plates measuring eight feet wide and forty long, and from 5/16 to 1½ inches thick, are readily handled. Hot plates, however, are not transported by the magnet lifts, as the heat injures the winding of the nagnets. Some of the magnets are smaller than others. The small ones are of later construction and are made after designs furnished by E. B. Clark, Electrical Engineer of the company, and although less than one-fifth the size of the larger ones, are more powerful.

After the plates are cut to suitable sizes they are removed from the shears and deposited in the shipping yard by overhead traveling cranes having only a single magnet. Similar cranes are employed in the yard for loading plates upon cars for shipment.

For handling the heavy ingots in the rail mill, and for introducing them into and removing them from the soaking pits, preparatory to rolling, an immense bridge crane is employed (shown on page 455), which is made on the rack and pinion order. The lifting hooks of this type of crane are attached to a vertical plunger with rack teeth that mesh into pinions which are operated by electric power. There is also a counterweight attachment which adds to the novel mechanical features of this crane.

In one of the other mills is still another type of electric traveling cranes for serving the soaking pits. In this the lifting is done by a pair of vertical screws driven by a motor, and this is capable of lifting enormous weights. There are also about the shops numerous other electric cranes and hoists, but these are not of special interest. Improvements in the line of braking mechanism for the larger lifts are contemplated.

POWER HOUSE.

The current for operating the various motors, and for lighting, is generated in a single plant recently constructed and which takes the place of three plants formerly required.

The interior of the power plant is shown on page 459, from which it will be seen that several types of generating units are employed. There is one pair of tandem compound Porter-Allen engines, each direct-coupled to a 400-kw. Westinghouse generator, which delivers a 250-volt direct current. There is also a 600-h. p. vertical cross compound McIntosh & Seymour engine direct coupled to a 300-kw. Westinghouse generator.

A very interesting feature of the power plant is the method of operating the lighting machines. The six arc machines are of the T.-H. type and are driven in pairs by a 100-h. p. Westinghouse motor, through flexible couplings. These motors are driven from the power generators above described. They require less attention than would engines and are more economical from the fact that large engines are employed for the initial power. There is also a 60-kw. alternating machine for the incandescent lights. The lighting equipment consists of 300 Standard arc lamps, 150 enclosed arcs and 1000 incandescent lamps.

The repair shop for the electrical equipment adjoins the engine room, in which an electric motor supplies the power for operating the gear cutters, engine lathes, planers and other tools required in the repair department. In this department is also an electric hoist for removing supplies from the basement directly under the repair shop; there is also a 20-ton electric traveling crane in the engine room.

It is estimated that a saving of 50 per cent. in the cost of power is effected by the use of motors in the various locations above described over that of steam power formerly employed.

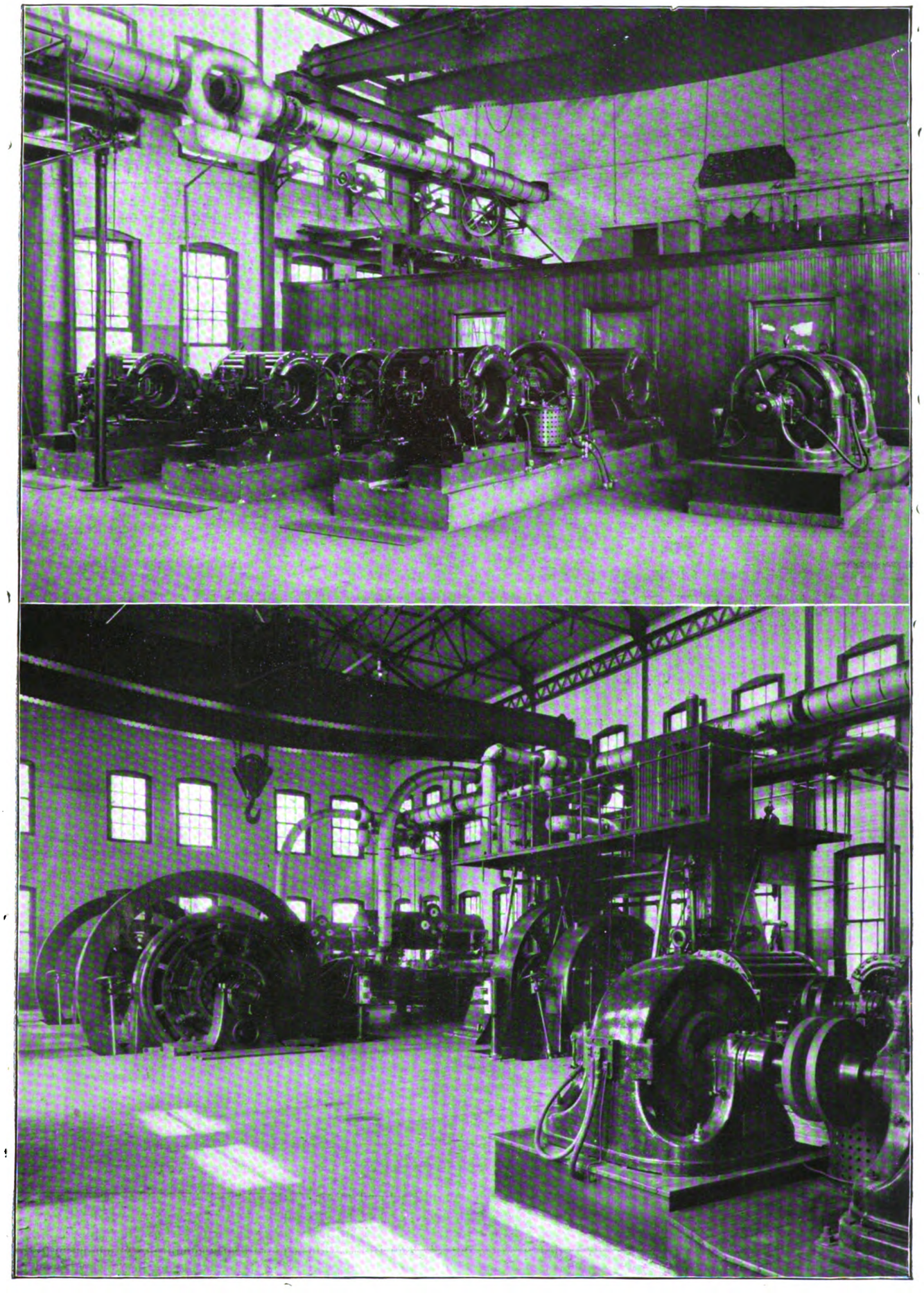
## A LIVE ELECTRICAL CLUB.

Nearly 150 young men attended the first fall meeting of the Y. M. C. A. Electrical Club recently held in the parlors of the Central Department of the Young Men's Christian Association of Chicago. In view of the fact that interest in industrial education is rapidly growing, this meeting is a significant one. The young men who are members of this club are engaged in electrical or allied pursuits during the day, and the club was formed by them more than two years ago for the purpose of securing facilities for an electrical education. It seems strange that in a city the size of Chicago there should be no provision made for the education of electrical apprentices, but the fact is that, outside of the efforts being made by this Y. M. C. A. Electrical Club, there is no opportunity offered to young workmen eager to improve their condition by evening study. As the work of this organization is an attempt by the young men themselves to fill a gap in our educational system which is so elaborate in nearly every other direction, it is a movement which should attract more than passing notice. The club is not a fad, but has behind it a record of over two years of solid growth, and its plans for the coming season have been developed from a recognition of the actual needs of the members. It has among its numbers several young men who are rapidly rising to positions of responsibility, and who owe much of their success to benefits secured through club work.

Last year the association management set aside a room to be used as an electrical laboratory, and the club collected nearly $1,000 worth of apparatus from various manufacturers as a laboratory equipment. It has been the aim of the club to secure one or more samples of the new electrical devices put upon the market from time to time, and to instal them for use in the laboratory, and it is under obligations to many manufacturers, who have kindly contributed to carrying out this idea. At the present time the club is interested in raising a fund of $2000 for the purchase of a complete set of practical testing and measuring instruments, and a number of very generous contributions from some of the large electrical interests of Chicago have already been received. This laboratory equipment is not opened indiscriminately to the use of the members, but is used in systematic study in the electrical classes, which are carried on under the international system so thoroughly developed by the Y. M. C. A.

Under this international system it is possible for every association in the country to do the same work in its evening classes. The prospectus of a course of study to be followed in both the elementary and advanced electrical classes has been carefully prepared by Prof. E. J. Houston of Philadelphia, and the printed examinations at the end of the year's

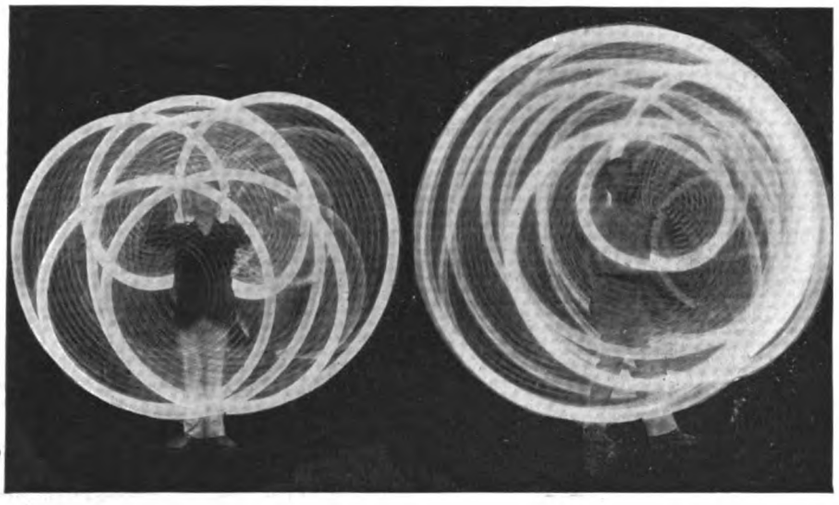
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Interior Views of the Power Plant of the Illinois Steel Works.

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work are of such high standard that the holders of certificates issued by the international committee are given credit for the work done in the classes in more than 100 universities and technical schools. In the international examination last year, three students in the elementary electrical class of the Chicago



ELECTRICALLY LIGHTED INDIAN CLUB EXHIBITION BEFORE THE CHICAGO ELECTRICAL CLUB.

department secured a grade of 100%, and two students in the advanced class stood 98% and 99% respectively, while the display by these classes at the international educational exhibit held at Grand Rapids, Mich., was given the highest award of merit. The electrical club naturally feels proud of the record made by the classes which are conducted as part of its work. For three years these classes have been in charge of Mr. Geo. A. Damon, electrical engineer for the Arnold Electric Power Station Company.

In addition to the classes in electricity, and as a result of some preliminary work along this line last year, there will be two courses offered this season in electrical laboratory work. These courses are intended to illustrate the principles taught in the classes and will be of a thoroughly practical nature. The club has been fortunate in securing the services of Mr. W. B. Hale, electrical engineer in charge of the testing laboratory of the Western Electric Company, who will have charge of the laboratory, and who brings into the work a rich experience in commercial testing methods. Mr Hale will be assisted by Mr. Fitzhugh Taylor, a senior student in the Armour Institute of Technology, and president of the club.

In addition to the classes, which continue for 25 weeks, beginning Oct. 1st, the club work includes an interesting program of meetings held upon the last Friday evening of each month during the period occupied by the classes, and every Friday evening for two months after the class work closes in April. These programs include excursions, practical talks and open discussions upon live topics. Last year the discussion on "The Electrical Business" was published in a number of technical papers, while Mr. A. V. Abbott's talk on "Wireless Telegraphy" filled the association hall with a paying audience. One of the most popular entertainments given by the club was that including the electrical spectacular effects originated by Mr. Geo. W. Patterson, who is a member. Mr. Patterson is the originator of the electrically lighted Indian clubs, and as he is an adept at swinging them, the graceful serpentine movements which he produces in a darkened room with the clubs illuminated by constantly changing multi-colored miniature incandescent lamps produce an effect which has been aptly termed "a new school of pyrotechnics." The illustration on this page shows a reproduction of a photograph taken by means of the light of the lamps alone, the small circles indicating the path of the miniature lamps, while the larger and brighter arcs mark the curves traced by 100-candle power lamps on the extreme ends of the clubs. Many other classes in the sciences, drawing and mathematics which are necessary for a complete electrical education are offered in connection with the evening college department of the association. These classes, together with those in other branches, make the association building the headquarters for nearly 1000 separate students during the evenings of the winter months.

This year's program includes an open discussion upon the subject "How to Become a Successful Electrician," and the book written by Sloane upon the subject will be taken as a basis. Last year the experience meeting upon "How I Got My First Electrical Job," was so successful that another experience meeting will be held this winter, the topic being "What I am Doing in Electrical Work." These experience meetings and open discussions bring the members closer together, and, in a number of cases, have been the means of some of the members securing a higher grade of employment. The "Members' nights" are always beneficial, as these evenings are taken up by papers prepared exclusively by the members upon subjects with which they are familiar, and it is one of the objects of the club to develop facility of expression in technical discussions.

The club is now planning to entertain its friends shortly with an "Evening with Statical Electricity." For this purpose they have interested Mr. E. E. Jewel, the president of the McIntosh Battery & Optical Company, who will display a sixteen-plate static machine, which is said to be the largest machine of the kind ever built. In addition to the striking phe-



MEMBERS OF THE Y. M. C. A ELECTRICAL CLUB OF CHICAGO

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nomena made possible by this monstrous machine, a very complete collection of beautiful Geissler tubes will be shown, while the X-ray effects made possible by the intense power developed by the sixteen-plate machine promise to be interesting.

An annual banquet is held each year during the Christmas holiday season, as the classes have two weeks' vacation at that time. At this banquet at least a dozen toasts are given by different members and an artistic menu card is usually a feature.

The club has the nucleus of a circulating library, to which important additions will be made this winter. This library is not intended to be complete, as only practical books which are suitable to the uses of the club members are secured, and it is remarkable how few books there are published of a thoroughly practical nature. In order to use this library intelligently the meeting in October will be a discussion of a paper upon the subject "What to Read and How to Read It." This meeting will be followed six months later by the library night, at which time it is proposed to have ten members review briefly some book in the library which they have read.

It will thus be seen that the work of the club is comprehensive, and is of such a nature as to furnish something of continued interest to each of its members. The three objects of the club as set forth in its short constitution are: Mutual improvement; entertainment of friends, and to augment a spirit of fraternity among association members. Judging from the results already obtained, the club is successfully carrying out all of its objects, and its methods might well be followed by clubs organized in a similar manner in many of the larger cities.

## ELECTRIC POWER IN A SHIP YARD.

The part which electricity plays in the building of the modern ship, as shown at the works of the Chicago Ship Building Company, embraces nearly every one of its ordinary applications, from lighting to telephone service, with the exception of heating. In the application of motors to the details of ship building it is believed that the Chicago yard is in advance of all other ship building plants in existence. This is doubtless due to the fact that the Chicago works are of recent establishment and purely modern design.

In order to understand the various uses of electricity at this point some idea should first be obtained of the character and extent of the yards and the work done there. The works of the Chicago Ship Building Company are located at 101st Street and the Calumet River, in Chicago, in the part of the city known as South Chicago. In building its plant the company has had one great advantage over most older establishments. The whole yard was laid out in the beginning for a complete plant. All additions made since the start have, therefore, been according to the original general plan. The yard is on this account more systematically and conveniently arranged than most yards that, starting on a small scale, have had their facilities extended by a process of gradual addition.

The Calumet River, at 101st Street, being only 225 feet wide, the Chicago Ship Building Company's yard had to be laid out to build ships on a level keel and launch them sidewise. Three slips at right angles to the river were dredged out and docked, giving six building berths. These building berths are kept in use almost continually. At present there are four ships in process of construction in the yard and one has been delivered within the last few days.

Two steam locomotive cranes run about on the tracks and do invaluable work in loading and unloading material. Besides the full gage tracks a complete system of Hunt narrow gage railroad runs from the plate and channel shops to the building berths.

In this plant some of the largest and handsomest vessels on the Great Lakes have been constructed. They are all built of steel, according to the most approved methods of modern ship building, with certain peculiarities and specialties of the Chicago Ship Building Company in addition. As a rule the largest size freighters are built, but some handsome passenger steamers have also been turned out by the company. Notable among them are the steamships Manitou and Illinois, the pick of all the vessels running regularly on Lake Michigan.

The part which electricity takes in building these great lake vessels begins at the power house. This building is situated almost exactly in the center of the big twenty-five-acre tract, and supplies every part of it with light and power. It is made of iron, thoroughly fireproof, and contains the boilers, engines and dynamos, as well as considerable air-compressing machinery.

The boilers are six in number. Two are Berry boilers of 300 h. p. each. The other four are of the Scotch marine type, of 500 h. p. each. They are located in the west wing of the power house, with the usual feed pumps, etc. The stack is of steel and is small, forced draft being used. The engine room takes up the greater part of the power house. It contains two large air compressors for the pneumatic service of the yard, the steam and electric units and the switchboard.

The main generating set consists of a 150-kw. Elwell-Parker dynamo, connected directly to a 200-h. p. compound Willans engine. For night service a 40-h. p. Edison dynamo belt-connected to a Rice engine is used. A spare General Electric dynamo of 50 kw. capacity, driven by a compound Lake Erie engine, is held in reserve for accidents.

The switchboard is necessarily simple and ordinary. Nine lighting and power circuits run out from the board to all parts of the yard, the largest wires used being 350,000 cm. in cross sections. The entire system, light and power, is run at 220 volts, direct current. There are thirty-five arc lights in use and 400 incandescent.

The power circuit has on it eighteen motors in various parts of the yard, aggregating over 300 h. p. The nearest is a few feet away from the switchboard, and the farthest is in the dry dock shop, over 2000 feet away. These motors range in size from 5 h. p. to 50 kw., and vary in type almost as widely. The variety of uses to which they are put is interesting.

The nearest motor to the switchboard is a 15-h. p. C & C. It is used to give the forced draft in the boiler room. In the blacksmith shop the most recent application of motors has been made. This is a new structure of iron and glass 60x100 ft. in floor area and 40 ft. high. It is equipped with the down draft system of the Buffalo Forge Company, which gives a blow and suction both at each forge. A 25 h. p. Crocker-Wheeler motor is belted directly without the intervention of line shafting to both blowers. Sixteen forges are thus supplied with air pressure, and have their gases removed.

The machine shop is the scene of the greatest use of electric motors in the Chicago Ship Building Company's yard and its owners consider it to be the finest specimen of a marine engine shop in the United States. It is constructed entirely of steel and glass, a large quantity of the latter material being used. It is probably the lightest shop of its kind in the country, and has been found cool in summer and easy to heat in winter. The main portion of the shop is 60 ft. wide and 60 ft. high to the roof trusses. There are no galleries, the work being done on the main floor, which is under the direct supervision of the foreman in charge. On either side of the central portion of the shop is a 30-ft. wing. In area, therefore, the shop is really 200 ft. long by 120 ft. wide. There are only eight columns in this space to obstruct the view or hinder operations.

The uses of electric motors in this shop are of two kinds, to drive line shafting and to run separate tools. Besides these, there is a traveling crane which is motor driven. The line shafting is located in the wings of the shop and drives the smaller lathes and tools. An Elwell-Parker 20-h. p. motor placed on a platform in each wing is belted to the shafting. The direct driven tools are in the main portion of the shop on the floor. The entire center portion is spanned by the electric crane, which is of the 25-ton size made by the Brown Hoisting Company. This is driven by three Elwell-Parker motors. The columns of the shop were made heavy enough to stand two 25-ton electric cranes, and undoubtedly the second one will be installed before long. Brackets were also put on the main columns about 25 ft. from the floor, on which to support a smaller crane girder. This is intended to carry a

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10-ton crane under the main cranes, which will be called on to do most of the light lifting in the shop.

The machine shop tools driven by motors are of particular interest, owing to their large size and remarkably successful operation. They include lathes, drills, planers and milling machines. A 72-inch screw cutting lathe made by the Niles Tool Works is fitted with a 5-h. p. Elwell-Parker motor. The feature of the machine-driven tools, however, is the Niles Tool Works horizontal boring mill. This is one of the largest tools of its kind in the country. It has proved remarkably handy on account of the variety of work it will do and the number of operations which can be performed at one setting of the work. This tool is driven by a 5-h. p. Crocker-Wheeler motor, which will give a wide speed variation to the drills. A vertical boring mill made by the Pond Machine Tool Company is run by a 10-h. p. General Electric motor at a constant speed.

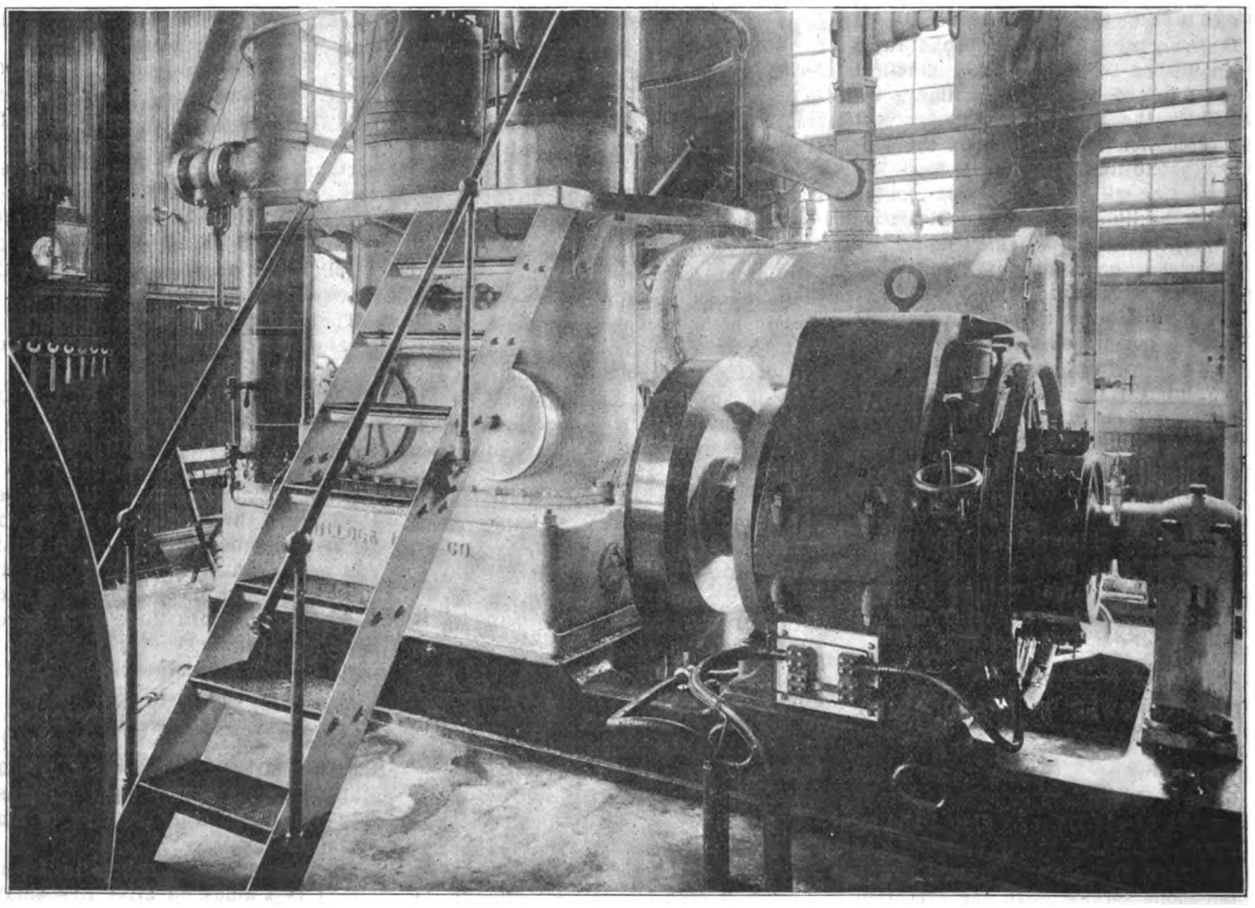
In the plate and channel shops, the various machines are all driven from line shafting, turned by electric motors. Two of the latter are used, one at either end of the building. They are put at the level of the line shafts on platforms, and are belted to the shaft pulleys. They drive, through the shafting, the punches, shears, rolls, reamers, planers and counter sinks used to handle the plates for the ships' sides, and the angle shears, punches and bending machines used on the angle irons. In the channel shop there is a powerful bending machine, built by William Sellers & Co., which will bend cold a 24-inch I beam between supports 4 ft. apart. All deck beams for the ships are cambered cold on this machine.

The joiner shop has the largest electric motor used in the yard. It is a 50-h. p. General Electric machine, and is used to drive the entire line shafting for the building. It is placed on a platform at one end of the building, and is belted to the shaft.

The dry dock is the largest on the Great Lakes. The extreme length is 540 ft. and width 100 ft. Sixteen feet of water is given over the mitre sill at ordinary river depth. The dock is emptied by steam centrifugal pumps with a capacity of 50,000 gallons a minute. A small oil burning plant is provided for the purpose. Beside the dock, and really forming part of it is the repair shed, or house, where the repair work on vessels is done. A 30-h. p. Elwell-Parker motor drives the line shafting in the building, turning the various lathes, saws and tools. It is connected in the same manner as the other motors driving line shafting. This motor is 2,000 ft. away from the power house.

Up to the present, the principal work in the building berths has been done by a pair of steam traveling cranes and the locomotive cranes. Now, however, 25-ton electric cranes are being installed over the berths, two for each of the four middle berths. They are made by the Brown Hoisting Company and fitted with Elwell-Parker motors. They are a great improvement in speed and convenience over the steam cranes.

On the dock at the river front stands a huge steel sheer with legs 100 ft. high. This is used for stepping masts and lifting heavy material, including the engines, into the ships after launching. It has a capacity of 100 tons. There are three legs, the back one being operated by a horizontal screw to throw the head of the sheer in and out. This screw is driven by a steam engine, but is soon to be operated by an electric motor. The sheer was made in the yard.



THE DIRECT-COUPLED WILLANS ENGINE AND ELWELL-PARKER DYNAMO OF THE POWER STATION OF THE CHICAGO SHIPBUILDING COMPANY.

In the finishing of the vessels the electric work is most important. Small marine electric lighting plants are now put in every ship of size, even if it is to be used only for freight. This work, as well as the general electrical supervision of the yard, is under the charge of C. C. Mattison, the electrician of the company. As high as 40 men are frequently employed in the wiring gang. A representative sample of the work done is in the Maunaloa, a large steam freighter, is 460 ft. long, deliv-

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ered to the Minnesota Steamship Company a few days ago. The electric plant consisted of two 10-k.w. General Electric marine type dynamos driven by high-speed engines. The switchboard, made by the Chicago Ship Building Company, is of slate, with Weston instruments and switches made in the works. Ten branch circuits run from the board. The wiring is all in moulding. The lamp sockets are made watertight both in the engine room and hold and above deck. The work is carried on in a construction and repair shop occupying a portion of the storehouse.

The telephone system of the works is one of the handiest things on the grounds. It was installed by the American Electric Telephone Company, with its apparatus. A 25-drop switchboard is in use, located in the office building. It has 20 telephones in the various buildings of the yard connected to it.

## THE "SAME CIRCUIT" METHOD OF INCANDESCENT LAMP PHOTOMETRY.

In the measurement of the candle power of incandescent lamps it is customary to use as a working standard of comparison at one end of the photometer some form of standard oil burner or a previously tested incandescent lamp carefully maintained at its rated voltage. A simple kink of photometric work known as the "same circuit" method, which does away with the bothersome oil burner and eliminates any calculation involving voltage, has come into extended use by lamp manufacturers, but does not as yet seem to be generally appreciated and used as it might be by central-station men. It is based on the principle that if two incandescent lamps are supplied from the same circuit, and are burned at about the same brilliancy, their candle power will increase and decrease in the same proportion with changes of voltage and their relative candle power will remain constant.

If then a working standard is mounted on one end of the photometer bar and the lamp to be tested at the other end, and both are supplied with current from the same source, even if the voltage fluctuates, the candle power of both lamps will go up and down together and the relative candle power or the position of the photometer screen over the scale will remain constant. Obviously no accurate voltmeter measurement is needed in this method of working.

The connections when working in this way are shown in Fig. 1, where S is the standard lamp and T that under test, connected across the same leads supplied from a source of power at the left. If this source of power is of much higher voltage than that of the lamps—as it is likely to be in central stations having a considerable drop in their feeders—a rheostat should be inserted at R to cut down the pressure to avoid deterioration of the standard as well as to bring the two lamps to about their normal voltage. Care should be taken in this case not to turn off the lamp, T, as the reduced drop in R would raise the pressure on the standard, S. Wherever a pressure within two or three volts of that for which the lamps are rated is available, no resistance is necessary.

A voltmeter may be inserted, as shown, in order to have the lamps at about their rated voltage, since, if the voltage is raised considerably above or lowered con-

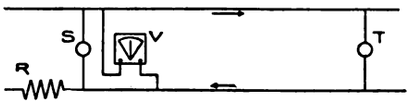



FIG. 1.

siderably below normal, the candle power of the lamp under test might not go up or down exactly the same percentage as that of the standard lamp unless both filaments were of the same physical characteristic, and particularly possessed the same ratio of graphitic to base carbon. Over considerable fluctuations of voltage, however, such as 3 or 5 per cent., the candle power of all lamps varies in so nearly the same proportion that the adjustment of the voltage, with any care whatever, is not necessary. The adjustment of the lamps to normal candle power by the eye is quite sufficient, so far as accuracy of the measurement is concerned. The meter may, however, be useful to prevent overburning the standard. Obviously the reading of this voltmeter does not enter into the calculation of the candle power which is read off immediately from the scale.

When it is desired to test lamps all of one rated voltage, the system is obviously most simple, and when lamps of different voltages must be tested the only addition necessary is a number of working standards, one for each different voltage. If it is not desired to keep in hand and calibrated so many different working standards, one may be made to serve over a small range of voltage by means of an adjustable photometric scale. For in-

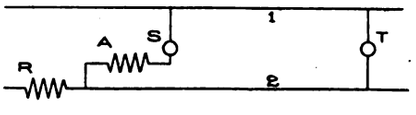



FIG. 2.

stance, if the working standard gives 16 candle power at 112 volts, 110-volt lamps may be compared with it by sliding the scale to favor the lamp under test by the difference between the candle power of a lamp burned at 110 and 112 volts. In the same way the 112-volt standard may be used for testing 114-volt lamps by sliding the scale in the other direction, i. e., to favor the standard, to a point determined by a graduated set of marks on the instruments. The tests may be carried out as explained above with a pressure on the lamps equal to or somewhat less than that at which the working standard is rated and either steady or fluctuating.

To reduce the number of standards required for a photometer designed to measure a general line of lamps from 50 to 250 volts, another modification may be made by inserting a resistance in series with the standard lamp alone. The arrangement of the circuit in this case is shown in Fig. 2, where the added resistance is represented by the letter A. This resistance should be made adjustable and may be calibrated so that even in this case no voltmeter measurement is necessary. An explanation of the proper value of this resistance is best given by taking a specific case. Assuming that the lamp, S, gives 16 candle power at 100 volts, and T is rated at 110 volts, the resistance, A, should be sufficient to absorb just 10 volts and give S 100 when the voltage between wires 1 and 2 is 110. The two lamps will then both receive their normal voltage when the difference of potential between the wires, 1 and 2, is 110 volts, and will rise and fall in candle power equally when the pressure varies. If the resistance of A is increased sufficiently to give a drop of 12 volts out of 112, it adapts the instrument to measure lamps of the latter pressure. Thus the photometer may be made to measure lamps rated at any pressure above that of the standard, in this case assumed to be 100. The resistance of A may be made adjustable with a contact traveling over a scale direct reading in terms of the voltage to which the resistance adapts the standard lamp so that when it is desired to measure lamps rated at 114 volts, for instance, the contact is set opposite the 114-volt mark, etc. The resistance should of course have a negligible temperature coefficient.

Portable photometers of extreme simplicity and light weight may thus be made and fitted with three standards, one for lamps of 55 volts or thereabouts, another for 110 volts or thereabouts, and a third for 220 volts or thereabouts. A description of such a photometer appears in the department of "New Apparatus and Appliances," in another part of this paper.

The "Same circuit" method should prove of the greatest value in central-station photometry where the simplicity of its apparatus and circuits, the absence of several simultaneous readings, the total elimination of corrections and calculations, and the ability to work over a considerable range of pressure, steady or fluctuating, should commend it for use in place of any other method.

**Another High Pressure Three-Wire System in This Country.**—The Narragansett Electric Light Company of Providence, R. I., is installing a three-wire distributing system with 450 volts between the outer conductors and 225 volts between each outer and the neutral. This is the second system of the kind in this country, the first being the well known Imperial plant in St. Louis, Mo., although a large number of such central stations are in service in England.

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## NEW DEVELOPMENTS IN STEAM SUPERHEATING.

It has always been recognized that a great gain in the economy of the steam engine could be accomplished by superheating the steam supplied to it, and many attempts have been made in the past to develop commercially practicable apparatus for this purpose. These attempts were invariably unsatisfactory, owing to several difficulties, mainly the burning out of the superheating apparatus and the impossibility of lubricating the engines at the high temperatures of the superheated steam, so that finally all work in this line was abandoned as impracticable. Like many other great improvements in engineering the difficulties in the way of steam superheating have been to a certain extent removed by the increased skill now customarily found in firerooms and the improvements in materials and design of boilers and engines, so that the way is now apparently open for the successful use of superheated steam, and many engineers believe that in this direction the next great advance in the economy of power production will be made.

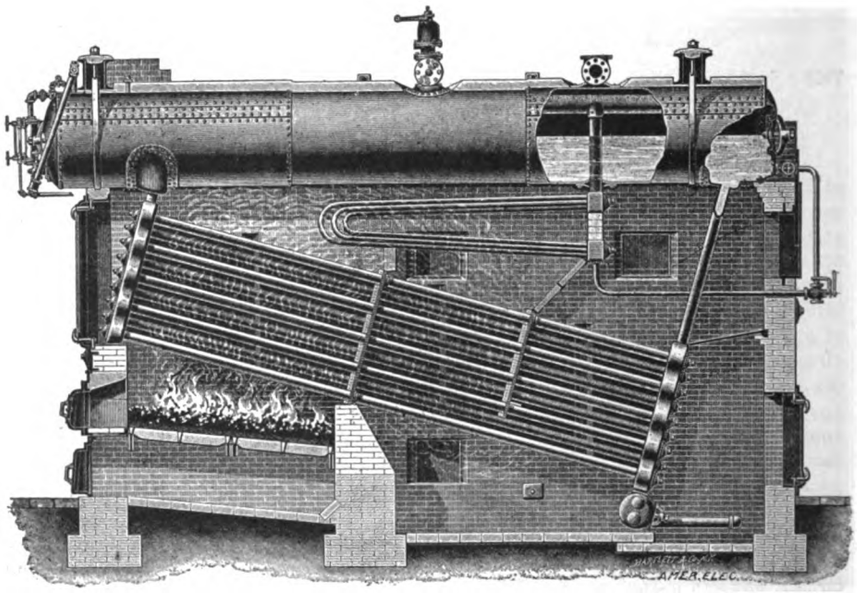
When water is evaporated into steam, as in the ordinary boiler, the fine bubbles of vapor that pass upward and are disengaged at the surface, are, of course, of exactly the same temperature as the water which they leave, any higher temperature on their part being impossible, as they would be instantly cooled by the water around them. This temperature is, of course, the boiling point of water at the pressure in the boiler, since the water cannot exist in the liquid form at a higher temperature at that pressure. The only way to obtain steam of a given pressure at a higher temperature than that corresponding to its boiling point at that pressure is to pass it, after it has been entirely disengaged, over independent heating surfaces, through which it can be heated up to any practical temperature desired.

The advantages of superheated steam are two, one of which may be termed theoretical in character and the other practical. The maximum theoretical limit of economy of an ideal engine is known to be proportional to the difference between the temperature of the entering steam and that of the exhaust. If an engine works between a boiler pressure of 100 lbs. and the atmosphere, the temperature of the incoming steam, if not superheated, is about 337° F., and that of the exhaust is 212° F., giving a difference between the two of 125°. If now the steam is superheated 125° at the same pressure of 100 lbs., the difference between the temperature of admission and exhaust will be 250°, and the steam consumption per horse power hour will be theoretically only half as great, although practically not quite as good results can be obtained. To attain the same temperature of admission without superheating would require a boiler pressure of nearly 400 lbs. to the sq. in.

In actual steam engine practice another great advantage is found in the reduction of what is called the initial condensation. When ordinary steam enters a cylinder which has during the previous stroke been open to the atmosphere or condenser, the iron walls, cylinder-head and piston are considerably cooled by the low temperature of the previously outgoing exhaust steam. A considerable amount of the incoming hot steam under pressure is immediately condensed into water by these cooled walls. This water is later re-evaporated into steam when the pressure falls off and the exhaust port is open, this steam passing away from the cylinder without doing any work whatever. If highly superheated steam is used the cool walls of the cylinder are heated up when new steam is admitted without condensing any water upon them, the steam being cooled somewhat but not to a low enough temperature to cause its condensation. Thus no water goes through the engine in the liquid form and the economy is greatly improved.

There are two radically different methods of generating superheated steam. One is the use of a boiler pressure considerably higher than the engine pressure, the steam being wire drawn on its way from the boiler to the engine. The heat liberated by the friction of the steam in passing through the reducing valve tends to superheat it at the lower pressure. It is quite customary in European torpedo boat and other high pressure steam practice to generate the steam at about 300 lbs. pressure and reduce it to 250 lbs. or so before it enters the engine. This practice reduces initial condensation, as pointed out above, although no great amount of superheat can be obtained in this way without enormous boiler pressures, but it does not tend in the slightest to obtain the first or theoretical advantage pointed out above, viz., an increased range of temperature; in fact, the initial temperature is somewhat lowered by the wire drawing process. The reduction of the steam pressure is thus, outside of the reduced initial condensation, a positive disadvantage, for the same reason that a throttling governor, for example, is a disadvantage as compared with an automatic cut-off mechanism.

The only other way to generate superheated steam is to take the saturated steam delivered by an ordinary boiler and pass it over independent heating surfaces, either in the boiler setting itself or arranged like economizers in the flue between the boiler and stack or heated by independent furnaces. The last arrangement is rarely if ever used for reasons that will appear below.



THE BABCOCK & WILCOX METHOD OF SUPERHEATING.

The location of superheating tubes in the flue receiving the hot gases after they have left the boiler requires a very great amount of superheating surface to accomplish any results, especially if the boiler is an efficient one, since the gases at this point should be thoroughly cooled to a temperature of at most about 500 or 600° F. It is obviously a radically wrong principle to pass the gases, when hottest, over the colder surfaces of the boiler, and then, when the gases become cool, to attempt to extract heat from them through the hotter surfaces of the superheating apparatus. Theoretically, the superheaters should receive the hot gases first from the fire, and after they have become cooled somewhat the gases should then pass on to the tubes of the boiler proper, where they could be cooled down to the lowest possible limit. Practically this is utterly unattainable, as a flame direct from the fire would immediately burn out superheating tubes, which, unlike boiler

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tubes or heating surfaces, are not constantly cooled by the contact of water.

A compromise between the theoretically ideal arrangement of the superheater next to the fire and the practical disadvantage of the same has been during the last few years incorporated in many boilers by the foreign Babcock & Wilcox Company, and is now being introduced into this country by the American house of the same name. The arrangement of the parts is shown in the accompanying vertical section of the boiler.

It will be seen that the hot gases and flame pass up as usual across the complete series of tubes and then strike the superheating tubes before they again return downward, recrossing the water tubes on their way to the flue. Thus the intense heat of the fire is tempered somewhat before the gases reach the superheating surfaces, where they are at a temperature of perhaps 800 to 1000° F., the gases afterwards being thoroughly cooled to as low a point as economy dictates by their repassage twice through the water tubes of the boiler.

The superheater consists, as shown, of a series of U-shaped tubes expanded into wrought steel headers or manifolds similar to those of the boiler proper. Opposite the ends of each group of 4 tubes in the header is a handhole cover. Steam is received into the upper header through two large pipes coming down from a perforated horizontal "dry pipe" placed in the upper part of the steam drum. The steam then flows through the tubes of the superheater to the lower header, which delivers it into two pipes, one to either side of the boiler, which convey it to a flanged tee shown just above the superheater, from which it flows through the usual piping to the engines. By this arrangement the temperature of the hot gases is, as noted above, reduced so that there is no danger of burning out the superheater while steam is flowing, and the harder the boiler is worked the hotter are the gases flowing over the superheating surfaces, so that the combination is practically self-regulating as to the degree of superheat.

The only risk of burning out is when the fire is pushed and no steam is being delivered to the engines. This occurs, as a rule, when steam is being raised hurriedly from cold water. To provide for such times a pipe runs from the lower part of the steam drum to the under side of the superheater and is provided with valves behind the boiler. By opening these the superheater is flooded and made a part of the steam generating surface. These valves should, of course, not be opened while steam is being drawn from the boiler, or water will be delivered to the engines. The lower valve is made three-way, so that the superheater may be drained before steam is turned on.

Many tests have been made with this device in various parts of Continental Europe which show well the economy to be obtained and the advantage of superheated steam in eliminating steam pipe condensation and delivering perfectly dry steam to the engines. The tests show as a rule that the steam consumption is reduced by superheating from 10 to 25 per cent., the greatest gain being effected in simple engines of low speed, and otherwise most wasteful through initial condensation.

## Among our Foreign Contemporaries

**An Arc Lamp Coupling.**—All of the English electrical papers have recently described a new device for hanging outdoor arc lights by which awkward looking loops in the conducting wires need not be left to give slack for lowering the lamp. The arrangement is shown in Fig. 1, the coupling details being shown in the broken vertical section to the left. The supporting cable, which, as usual in English practice, rises through an ornamental pole, passes down through a bell or dome-shaped cap and carries at its lower end what might be called an attachment plug wired to the lamp. This, when the lamp is pulled up, enters a circular receptacle protected from the weather under a cap. The plug and receptacle contacts are concentric with the cable so that any twisting of the lamp does not affect them. When the lamp is lowered it is, of course, entirely cut out of circuit, eliminating any risk of shock. The springs for maintaining good contact are fixed to the plug so that they come down with the lamp and are accessible for renewal, the receptacle which stays up being of the simplest character, its contacts consisting simply of solid metal rings. The running of the suspension cable through the center of both plug and receptacle insures their concentric meeting when the lamp is raised. The receptacle shown is obviously for multiple work, the circuit being opened when the lamp is opened. It could, however, be adapted to series work by fitting it in such a way as to automatically short circuit the line when the lamp is lowered.

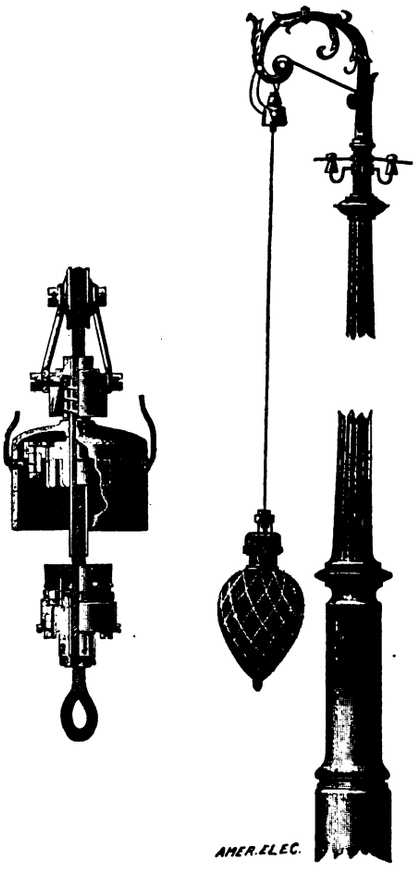



FIG. 1.—A COUPLING FOR DISCONNECTING ARC LAMPS WHEN LOWERED AND FOR AVOIDING SLACK CONDUCTING WIRES.

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**An Automatic Cutout for Fallen Trolley Wires.**—In English electric railway practice it is customary to connect the feeders, which are almost universally underground, to the trolley wires through what are called feeder pillars. These consist of cast iron cases standing in the streets, resembling in appearance large hydrants, and containing lightning arresters, pilot wire terminals, switches by means of which the current can be cut off, and in some cases fuses or circuit breakers. An ingenious arrangement of a circuit breaker for use in such locations, designed to cut the current off instantly in case the trolley wire supplied through it is broken, is now in use on the Blackpool tramways and was recently described in the London "Electrical Review." The breaker is supplied with both shunt and series coils, the purpose of which is the same as that of the no voltage and overload release devices used on motor controllers in this country. The shunt coil is connected by means of a pilot wire to the end of the section of the trolley wire supplied through the breaker, and if this section of the trolley wire breaks at any point the shunt circuit is no longer energized and the breaker flies open before the trolley wire can reach the ground. The series circuit provides for the usual opening of the breaker on overload or short circuit. The only apparent objection to such a device is the fact that in case of failure of the current from any cause, as trouble at the power station, all the circuit breakers at all the feeder pillars on the lines will be opened.

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**The Side Trolley.**—The overhead trolley system of most English street railways differs from that of American railroads in that no attempt is made to carry the trolley wire over the center of the track or, indeed, within 8 or 10 feet of it. The trolley wire being carried often away off

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to one side, the trolley pole has to be capable of swinging out at an angle from the direction of the track, and the trolley wheel has to be swiveled so that when the pole is at a considerable angle the wheel itself can assume the direction of the trolley wire. The trolley has also to be made different from American standards in order to be worked on double deck cars, on which American trolleys would interfere with the passengers. Fig. 2 shows the construction of the Siemens pole, in which it will be seen that the pole proper does not start from a point near the roof of the car but springs from the top of a vertical standard 6 feet in height, which raises the pole so that it clears the passengers' heads. This standard is not necessarily centrally located on the car, but is generally placed off to one side. The trolley pole is fastened to a turntable which is supported on ball bearings on the top of the standard so that it is free to turn readily. The pole is forced up against the overhead wire by a long and powerful coiled spring entirely contained within the inner tube of the standard. Within the spring is the conducting cable, which must be insulated from the ironwork of the overhead system, since it is on a passenger deck. The conducting cable is attached to a collector ring at the lower end of the inner tube, the brush bearing on this collector ring taking the current to the motor below. The flexible cable passes up inside the pole to an insulated cap which appears in the enlarged view of the details, this cap being attached by a flexible cable to the harp carrying the wheel. This harp is also supported on ball bearings so that it is free to turn around a vertical axis and the cap on the end of the pole is loosely fastened so that if the wheel catches in the overhead wires it will be pulled off without wrecking the standard or the top of the car.

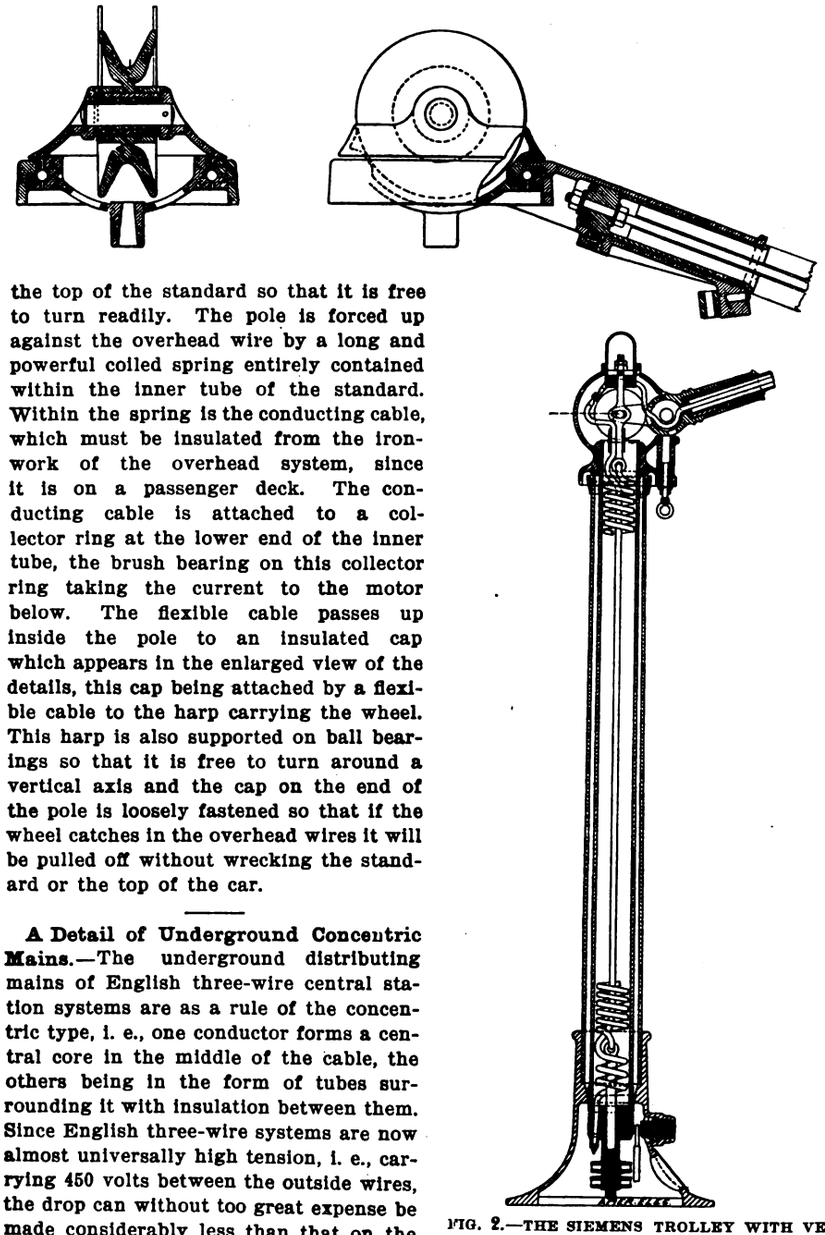


FIG. 2.—THE SIEMENS TROLLEY WITH VERTICAL STANDARD FOR DOUBLE-DECKED CARS AND TURNTABLE AND SWIVELING HEAD FOR SIDE TROLLEY WIRES.

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**A Detail of Underground Concentric Mains.**—The underground distributing mains of English three-wire central station systems are as a rule of the concentric type, i. e., one conductor forms a central core in the middle of the cable, the others being in the form of tubes surrounding it with insulation between them. Since English three-wire systems are now almost universally high tension, i. e., carrying 450 volts between the outside wires, the drop can without too great expense be made considerably less than that on the 220-volt systems used in this country, and the loads therefore do not require to be so accurately balanced between the two sides of the system. It is in consequence customary to wire houses and other moderate-sized loads two-wire and connect them between one outer wire and the neutral. If the neutral is made the middle conductor of the three in the concentric cable, the inside conductor or core does not need to be tapped at the service branch boxes. If, however, all loads along one section of the mains were connected between the outer conductor of the cable and the neutral, this section would be badly unbalanced. To get around this difficulty there is installed on such systems at intervals what is called a reversing junction box, a plan of which is shown in Fig. 3. As may there be seen, the triple concentric cable coming in from the left is stripped in steps and laid alongside that coming from the right, and the outer conductor of one is connected to the central core of the other, the two middle conductors forming the neutral being connected to each other. In this way the positive side of the system is the outer concentric tube for one section, while beyond the next reversing box the negative side of the system is connected to the outer concentric conductor. Services branched off from the outer conductor and the neutral may in this way be balanced. The connections are made by pieces of gun metal sweated to the conductors. The joint is then taped over and the box is filled with compound. Fig. 4 shows a vertical section of one of the branch boxes for the services. A piece of the outer conductor is removed and the ends are connected by a gun metal connector so as to give access to the neutral. The two branch leads are brought up through ebonite bushings into a chamber in which fuses are mounted on a porcelain base. This chamber is covered by a glass window mounted in the cast iron frame, the whole being watertight. The box is located in a brick manhole with a cast iron cover so that it can be inspected and re-fused at any time.

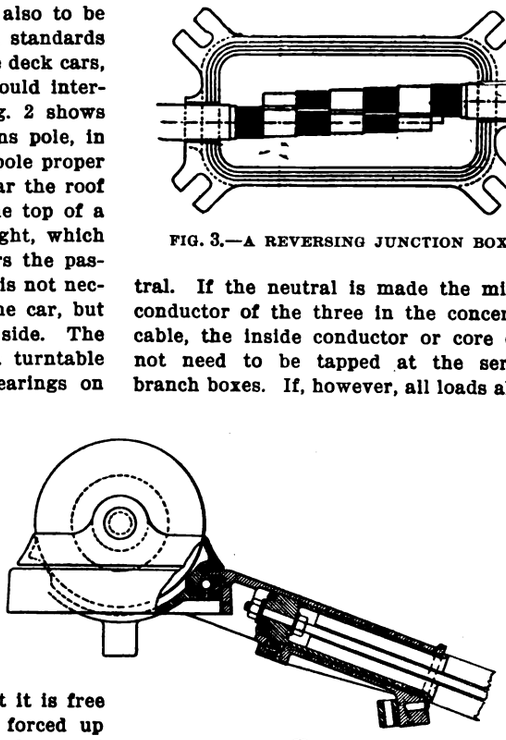


FIG. 3.—A REVERSING JUNCTION BOX.

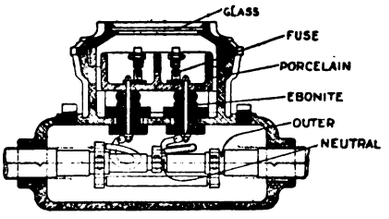



FIG. 4.—A SERVICE BRANCH BOX.

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**Automatic Accumulator Disconnector.**—In order to automatically disconnect a battery of accumulators from a charging circuit, when they are fully charged, Dr. Peterson of Copenhagen has devised a comparatively simple apparatus which is described in the "Elektrotechnische Zeitschrift." The principle of the operation is that one of the batteries is hermetically sealed and has two bent glass tubes leading to the interior and containing mercury in the lower bend, so that when gases are generated in the cell they will press on one end of the mercury column, thereby changing its level; platinum wires are fused through these tubes in such a way that when the level is changed a certain amount, the circuit is broken by the mercury. The illustration, Fig. 5, shows the arrangement of the circuits diagrammatically. The right hand one of the two bent tubes containing the mercury, the lower ends of which pass into the interior

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of the cell, is for breaking the main charging circuit, the diagram showing the conditions during charge. After the circuit has been opened the switch U is turned and this disconnects the bat-

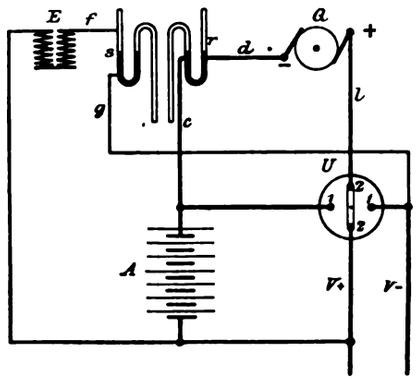



FIG. 5.—A SWITCH WORKED AUTOMATICALLY BY THE "GASSING" OF STORAGE BATTERIES TO CUT OFF THE CHARGING CURRENT.

tery and the charging circuit. The left hand tube is for operating the electromagnet E, which is connected only to the discharging circuit as shown, and operates a valve which releases the air pressure in the accumulator when the armature is drawn up; when the switch U is turned for discharging, a momentary current will flow through that electromagnet and this opens the air valve and allows the mercury in both tubes to assume its original position. In order to prevent the columns of mercury from moving up and down with a pendulum action, the bottom of the mercury tube is made extremely small, so as to allow the mercury to flow through only slowly. An alarm bell to indicate when the batteries are charged could very easily be added.

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**An Odd Inductor Dynamo.**—Foreign papers have recently published many notes from correspondents at the electrical exhibition at Como, Italy. Among these notes many interesting types of machines are described. One unusual machine is that shown in Fig. 6, which is reproduced from the London "Electrical Review." The peculiarity of the machine is the fact that the field and armature coils are wound on the same poles, the rotor serving merely to vary the mutual induction between the two circuits. Although one of the first inductor dynamos ever proposed was designed on these lines, such a machine has never been reduced to practice in this country. It will be noted from the figure that the coils are all pole-wound upon the internally projecting poles of the external stationary ring. There are three times as many of these poles as there are rotor poles facing them. Each armature coil is closely sandwiched between two field coils on each pole, this arrangement reducing magnetic leakage. The field coils are so connected as to make alternate poles north and south, and the rotor as it draws away from one stationary pole approaches the second one from it, so that the average reluctance of the magnetic circuit through all of the field coils is not varied and the movement of the rotor therefore causes no alternating back e.m.f. to be impressed upon the field circuit. There are three times as many stationary poles as there are moving poles and the coils of one phase are mounted upon every third pole. It will be noticed that all the poles of one phase are at one instant covered by the iron of the rotor and at another instant uncovered and confronted only by a wide expanse of air. This causes the flux in any individual pole to vary up and down as its magnetic circuit is closed and opened, setting up alternating currents. There being three times as many poles on the stator as there are on the rotor the coils give currents displaced one-third of a cycle from each other, i. e., they give three-phase currents.

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**The Connections of Subcribers' Instruments on Common Battery Exchanges.**—It frequently happens that American electrical publications are obliged to obtain information on American subjects



FIG. 6.—AN INDUCTOR DYNAMO WITH THE ARMATURE AND FIELD COILS WOUND ON THE SAME TEETH.

from foreign sources, owing to the reluctance of those in authority on this side to give out the same information. Such a case is that of the common battery telephone system used by the American Bell Companies and constructed by the Western Electric Company. In an article which recently appeared in the London "Electrician" many of the details of this system were given out, one of the most interesting features hitherto unpublished being a special method of connecting the subscribers' instruments, wherein an induction coil is used for purposes mentioned below.

Translating the English diagram into American conventional forms, the instrument is shown in Fig. 7. From this diagram it may be seen that when the receiver is on the hook switch the only path from line to line through the instrument is via the magneto bell in series with a condenser. This allows the ringing currents to actuate the bell, but holds the line open against the battery electromotive force constantly applied from the telephone exchange. When, however, the telephone receiver is removed from the switch a metallic connection is made across the line through one side of the induction coil and the microphone. This allows the passage of direct current from a common battery, which operates a relay attached to that line at the central exchange, this relay illuminating the proper visual line signal in front of the answering operator at the switchboard.

The hook switch also closes another circuit through the two sides of the induction coil in series with each other and in series with the receiver, this whole circuit being in parallel with the magneto bell and in series with the condenser across the line conductors. Direct current does not pass through this line, as the condenser is contained within it, but alternating voice currents do. The primary of the induction coil, i. e., the winding connected in series with the transmitter, has a resistance of 15 ohms, while the secondary, i. e., the winding in series with the receiver, has a resistance of 30 ohms. As voice currents from the distant end of the line must necessarily, in order to reach the receiver, pass through these two coils in series with each other, they are necessarily wound and connected in opposite directions, i. e., a current which circulates in one right-handedly circulates in the other left-handedly, so that they in part neutralize each other's effect upon the core, and hence do not act as an inductive coil to choke alternating currents passing through them in series, except in so far as one has a greater number of turns than the other. It will be noticed that apparently the path from one line through the 15-ohm coil and the transmitter to the other line would tend to short-circuit the receiving instrument and reduce the effect upon it of voice currents from distant stations, but this is compensated for by the transformer action of the induction coil, which, when alternating cur-

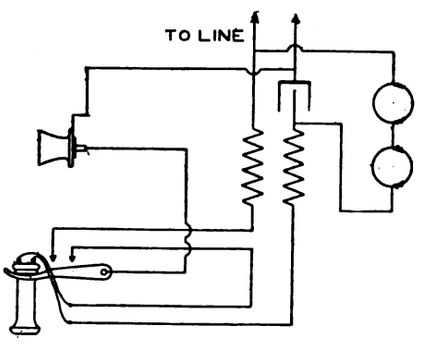



FIG. 7.—THE USE OF AN INDUCTION COIL ON A COMMON BATTERY SYSTEM.

rents pass through its 15-ohm side sets up similar currents in the 30-ohm coil in series with the receiver and condenser. It is noticeable, however, that these currents in the 30-ohm coil necessarily have to pass through the 15-ohm coil; thus the

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induction coil connected in this manner serves as a choke coil to prevent alternating currents from short-circuiting around the receiver through the transmitter, and also serves to allow direct currents to pass from the line through its primary and the microphone without

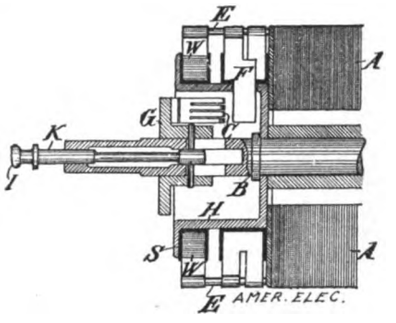



FIG. 8.—AN ARRANGEMENT FOR SHORT CIRCUITING ROTATING RESISTANCES IN AN INDUCTION MOTOR.

passing through the comparatively high resistance receiver, a very desirable object. The system of connections is a most ingenious one and is the outcome of several less perfect ones drawn up by engineers of the American Bell Company. The article above referred to gives other details, some of which have appeared in American publications through patents issued to their inventors.

**A Starting Device for Induction Motors.**—For maximum efficiency the polyphase induction motor must be made with a secondary circuit of as low a resistance as possible, the secondary usually being a squirrel cage of copper rods riveted to copper rings. This arrangement is, however, badly adapted for starting since, when the magnetic field is rotating at a speed much higher than that of the rotor, as it is when the latter is at or near standstill, the electromotive forces in the short circuited secondary are correspondingly higher, due to the increased rate of cutting lines of force, and excessive currents are set up. These not only require an excessive current from the line, but by their distorting action on the field tend to cause serious magnetic leakage between the primary and secondary and thereby not only greatly reduce the torque per ampere, but even reduce the total torque in spite of the excessive number of amperes. The simplest means of overcoming this difficulty is to insert in the secondary circuits, while starting, a group of non-inductive resistances, which will check this excessive flow of currents and with which the torque per ampere can be made as high at low speeds as at full speed, although of course at a reduced efficiency, due to the reduced output of power at the low speed. One means of accomplishing this is to wind the secondary with coils connected to collector rings from which the currents can be led out to resistances or short circuited. This, however, does not allow the use of a cheap and durable low voltage bar winding or squirrel cage, as the collector ring resistance would prove too high for the large currents generated by it. In a series of notes on electrical features of Switzerland appearing in the "London Electrician" for the benefit of the excursionists of the Institution of Electrical Engineers who recently visited Switzerland, the Alioth starting device was described. It consists of a set of resistances inserted in the secondary windings and rotating upon the shaft of the machine with a special rotating switch for short circuiting them when the machine approaches full speed. The arrangement of the parts is shown in the accompanying diagram, Fig. 8, in which A represents the laminated core of the rotor of the motor and E and E represent bars of the winding. These bars are cross connected with spiral end connections in the usual way just to the left of the end plate of the core, but a few of them (3 per pair of poles) extend further out to the left and are connected to resistance straps, W. The bars also carry knife contacts, F, which may be closed upon the jaws, C, mounted on the disc, G. This disc is mov-

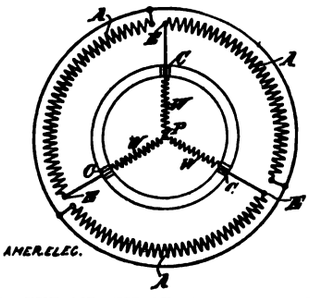



FIG. 9.—THE CIRCUIT OF THE SECONDARY OF THE MOTOR SHOWING RESISTANCES AND SHORT CIRCUITING RING.

able axially by means of the central spindle, K, through the hollow shaft and attached to the handle, I. When this handle is pushed in the jaws make contact with the strips, F, and thereby short circuit the resistances, W. A diagram of the circuits is shown in Fig. 9, in which A A A are the secondary windings Y-connected to the external circle. The windings evidently generate currents through the Y-connected resistances, W W W, to the common central point, P, except when the resistances are short circuited by the ring, C C C. A similar arrangement is used by the General Electric Company of this country, the main difference being that in its device the movable contacts sweep over a number of segments, cutting out the resistance gradually instead of in one step.

**A Combined Hydrocarbon and Electric Motor Automobile.**—The advantages of the easy starting and overload capacity of the electric motor and the continuous operation of the gas engine have been combined in a line of automobiles in this country, a description of which appeared in the July issue of the American Electrician, and also in a vehicle called the Petro-Accummobile, manufactured by Les Etablissements Pieper, a description of which recently appeared in "l'Industrie Electrique." A general view of the running gear with the body removed is shown in Fig. 10. The gas engine is in this case of the vertical, single-cylinder trunk piston type and is mounted forward on the vehicle over the forward axle, extending up under a hood which constitutes the dash board. It drives through a horizontal shaft a dynamo mounted centrally under the vehicle, and the shaft extends through to the rear of the dynamo and enters a changeable gear, the casing of which appears at a slightly lower elevation than that of the electrical machine. This gear in turn drives through a bevel and differential gear at the rear, connected to the axles of the driving wheels. The gas engine runs constantly at approximately uniform speed and output whether the vehicle is moving rapidly or slowly or standing still, the control of the speed being accomplished solely through the changeable gear. The excitation of the dynamo can be changed slightly to vary the speed on any one gear. The only time it is necessary to stop the gas engine is when it is desired to reverse the direction of the vehicle. This is accomplished by running the dynamo backwards as a motor. In regular running, the dynamo acts either as a generator or a motor according to whether the output of the engine is greater or less than the power used by the vehicle. The total weight of the latter, which is a trap with one seat for two passengers and a rear seat for a groom, is, without passengers, about 1300 lbs. The output of the gas engine is the equivalent of 2500 watts and the capacity

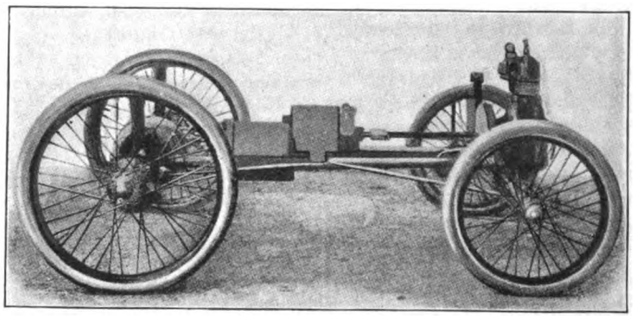


FIG. 10.—THE RUNNING GEAR OF A FRENCH AUTOMOBILE WITH A GASOLINE ENGINE AND DYNAMO AND STORAGE BATTERY.

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of the dynamo and of the storage battery is in the neighborhood of 1800 watts. The battery weighs only about 270 lbs. all told and is capable of discharging at the high rate of about 9 watts per pound of total weight, this high rate of discharge being due to the fact that it is always charged up to a high pressure and constantly receiving and taking charges for a short time duration, never being called upon for a long continued discharge.

# Some Recent Electrical Patents.

**An Electrolytic Lamp.**—Electrical engineers in this country have not been idle in the development of electric lamps on the general lines of the Nernst lamp. A patent recently issued to W. E. Irish describes a modification of the ordinary arc lamp by means of which a rod or tube of some material which, when heated, conducts the current and emits light at a high efficiency, is substituted for the arc between two carbons, the arc serving as a means of heating this material and thereby starting the lamp. One proposed arrangement is shown in the vertical section reproduced in Fig. 1, in which 1 and 1 are the carbons between which an arc is sprung, which heats up the sleeve of a normally non-conducting oxide of a rare earth until it conducts the current from one carbon to the other, when the arc may be extinguished, the lamp becoming electrolytic in character. Patent No. 626,787.

**An Electrostatic Measuring Instrument in Vacuo.**—For the measurement of very high voltages or the detection of grounds upon high voltage lines, electrostatic voltmeters are far preferable to electromagnetic instruments owing to the enormous resistance that must be used with the latter as well as to the considerable loss of power required to give sufficient current to operate the instruments. Electrostatic instruments get into difficulties, however, at these pressures owing to the sparking distance and the necessity of separating the fixed and movable element of the measuring instrument a considerable distance apart, which greatly reduces the inherently weak force of electrostatic attraction and repulsion. Prof. Elihu Thomson has patented a means of overcoming this difficulty by enclosing the instrument in a glass tube or bulb, exhausted to an extremely high Crookes vacuum so great that the sparking distance of a given voltage is greatly reduced and the vanes and quadrants can be brought with safety much closer to each other than they could in open air, thereby increasing the electrostatic forces which give the measuring deflection and reducing greatly the delicacy of the instrument. A suggested arrangement is shown in plan in the cut, Fig. 2, wherein F is a base, B is a Crookes tube containing the vanes, $S^2$, working between the quadrants, $S^3$, connected with the terminals, T and T'. The vanes are restored to the zero position by the spiral spring shown and indicate by means of the pointer, C, working over the scale shown in the lower part of the figure. The claims upon this improvement are extremely broad, covering generally the enclosure of a measuring instrument in a vacuum. Patent No. 627,155.

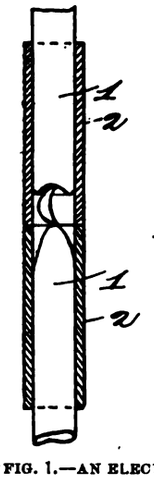



FIG. 1.—AN ELECTROLYTIC LAMP.

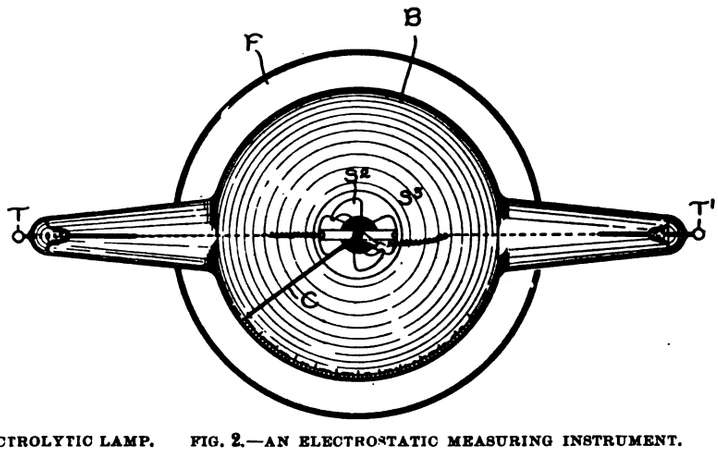



FIG. 2.—AN ELECTROSTATIC MEASURING INSTRUMENT.

**A Relay Switch for Sectional Conductor Railways.**—There have been many plans proposed and patented for the operation of the switches of sectional conductor or button-contact railways by means of magnets carried by the cars and projecting their fields of magnetic force down through the road bed to magnetically operated switches buried therein. One difficulty with such systems is the transmission of sufficient magnetic intensity through the necessarily wide air gap to operate switches of the size and weight required for making and breaking street railway circuits. A recent patent issued to Mr. Robert Lundell describes and claims the use of a relay buried in the ground and affected by the magnetism sent into it from the car above, this relay having moving parts of light weight which close the circuit of a main switch which may be located near by or grouped with other switches in what is known as the vault system. In Fig. 3, which is a diagrammatic cross-section of the track, R and $R^1$ are the service rails, B is the third rail or button contact on which slides the shoe or skate $S^1$ attached to the car, and N and S are long parallel rods of iron or steel magnetized by the magnet M, which is supplied, as shown, with current from the storage battery $B^4$. These send downward into the roadbed the field of force represented by the dotted lines, which affects the small relay D, one for each section of the track. The moving parts of this relay are connected in circuit between an auxiliary feeder of low voltage, $F^1$, and the coils of the main electro-magnetic switch, $M^1$, so that when the relay is affected by the magnetism sent to it by the car it closes the circuit, which energizes the main switch, which in turn connects the sectional conductor with the main feeder, F. Patent No. 625,512.

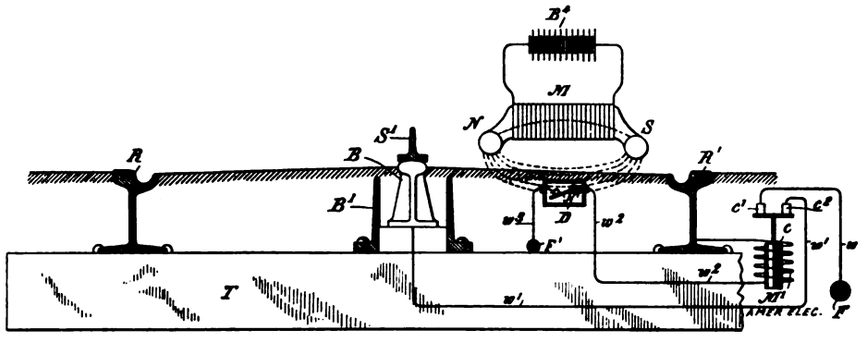



FIG. 3.—A RELAY SWITCH FOR SECTIONAL CONDUCTOR RAILWAYS.

**A Pneumatic Multiple-Unit System.**—The operation of the various controllers of the several cars of a train composed of motor cars, all from one platform, in such a way that the motors shall all work together, requires apparatus of considerable complexity, which has in the few designs hitherto proposed been entirely electrical. Mr. Geo. Westinghouse describes a complete arrangement for this purpose in a patent containing 12 sheets of drawings and 43 claims, in which apparatus the pneumatic pressure of the air brake system is made use of to operate the controllers, the valves being actuated by

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magnets, the whole arrangement of brakes and controllers being closely interacting, so that, among other things, the application of the brakes serves to cut off all current from the motors. Patent No. 624,777.

**An Automatic Grounding Device for Secondary Circuits.**—To maintain insulation between secondary alternating cir-

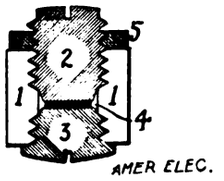



FIG. 4.—AN AUTOMATIC GROUNDING DEVICE FOR SECONDARY CIRCUITS.

cuits and ground, except when they become crossed with the primary under such conditions as to establish a high and dangerous voltage between the secondary and ground, Messrs. E. J. Houston and A. E. Kennelly have patented a new form of insulating gap such that the high tension will break down its dielectric strength, the general purpose of which is the same as that of the Cardew earthing device or the Thomson film cutout. The new device consists of a small button or layer of a chemical substance which allows but a trifling leakage of current at low voltage, but when subjected to high pressure undergoes a chemical change which reduces its resistance. Among the commercial substances which they suggest are: Manganese dioxid, stannous chlorid, lead acetate, copper bichlorid, copper and ammonium chlorid, and silver sulfid. The accompanying drawing shows one arrangement of such a device, consisting of an insulating sleeve, 1, tapped to receive the metal plugs, 2 and 3, between which is the chemical substance, 4. One of the metal plugs is then connected to the circuit to be protected and the other to the ground. Patent No. 625,395.

**A Glycerine Switch for Railway Controllers.**—To take the arc which always exists in breaking the circuits of railway motors, Mr. H. A. Wurts, the designer of the well known Wurts lightning arrester, has patented a special form of switch to be used in combination with the Westinghouse controller, as shown in the broken elevation, which is reproduced in Fig. 5. The switch is located below the controller proper at a point represented by 12 in chamber 8, which is filled with some liquid, preferably glycerine for reasons given below. The switch is actuated by means of a peculiar friction clutch upon the controller spindle proper. This clutch is so designed as to open the switch when the controller passes from the series to the multiple position and also when the controller is turned from any running notch toward the off position, so that the current is not passed through the controller contacts as they travel under the fingers while the power is being shut off. Mr. Wurts states that as a result of his experiments he found that any non-conducting liquid, if closely confined so that the arc has no chance to vaporize it and provide itself with a gaseous path through the liquid, is suitable for use on such a controller. For this reason the chamber is made with no outlet except a small pin hole, shown at 15, and put in so that the liquid shall not burst the strong walls in case of expansion. The liquid should be one which is not easily carbonized and which is non-combustible, and preferably having a slight conductivity so that the induced electromotive force of self induction on breaking the circuit shall have a path for its discharge. The liquid should also be unchanged by the extreme variations of temperature to which a railway motor is likely to be subjected. Glycerine has been found to best meet these requirements. The claims are

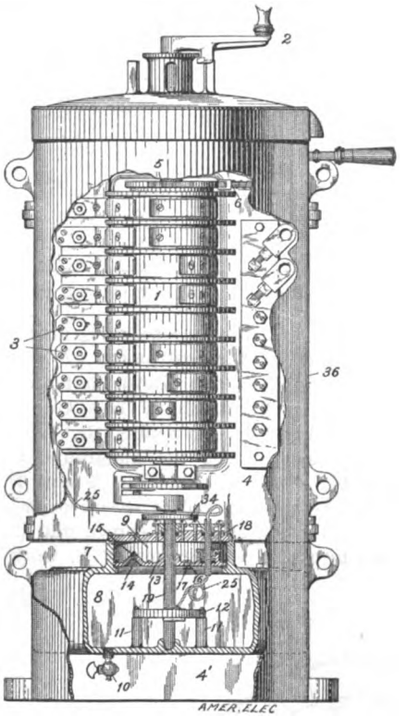



FIG. 5.—A GLYCERINE SWITCH FOR RAILWAY CONTROLLERS.

very broad, the first reading: "The combination in an electric controller of a switch and an auxiliary switch in circuit therewith having its contact portions immersed in an arc extinguishing preparation." Patent No. 625,232.

**An Incandescent Lamp Filament of Highly Refractory Material.**—Mr. T. A. Edison, in his characteristic way of taking up and developing the different branches of electrical engineering in which others have started notable improvements, has recently filed an application on a lamp using a filament of a highly refractory non-conducting substance, evidently inspired by the promising future of the Nernst, Maxim and other lamps of recent invention. In an equally characteristic way he describes and claims broadly a form of construction which is, in the present state of the art, apparently quite impracticable, but which may establish his claims to valuable processes should this branch of electrical engineering develop to a high state of perfection later. The invention consists of a filament of a highly refractory non-conducting material, preferably porous, incorporated in which are isolated particles of carbon, such as to produce spark gaps within the filament, across which gaps high-tension currents may be discharged and by their sparking be made to heat the filament to incandescence. The materials mentioned are the oxids of the rare earths, zirconium, thorium, etc., in which the isolated particles of carbon may be incorporated by the carbonization of an organic compound mixed with the oxid or the carbonization of the tartrate of the oxid itself. The patent also describes the dipping of the filaments in a salt of the oxid, such as the acetate, to provide an exterior surface of high emissivity. The first claim of the patent is extremely broad and reads as follows: "An improved filament for incandescent lamps, consisting of a highly refractory non-conducting material, having isolated particles of conductive material therein, substantially as set forth." Patent No. 626,460.

**An Improved Binding Post.**—One of the most troublesome features of electric bell, signal, telephone and telegraph systems is the binding post, which is so likely to work loose in time and give a poor connection. For this reason it is common in high-grade telephone work to solder a great many joints at the expense of considerable inconvenience in changing the circuits. An improved form of binding post in which a lock nut performs a double function is shown in two views in Fig. 6, and is patented by Mr. J. F. Gilliland. It is of the upright form, tapped at c for fastening upon the usual machine screw, with projections b b for holding it from twisting on the base upon which it is mounted. It is drilled with the usual lateral hole, C, to receive the wire to be fastened into it which is bound by the screw B, which, in turn, is fastened by the lock-nut D. The main post is split, as shown at a, and terminates in

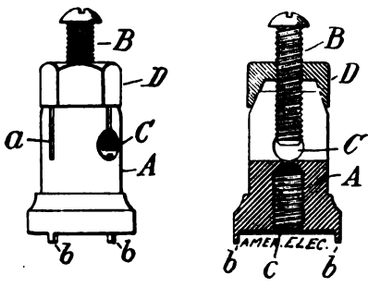



FIG. 6.—AN IMPROVED BINDING POST.

a conical end which is enclosed by the countersunk section of the lock-nut. The latter, therefore, acts as an ordinary lock-nut and also serves to jam the four sections of the post around the screw. The spring of these sections, combined with the wedging action of the tapered nut, gives a fastening which is not liable to work loose. Patent No. 625,668.

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# NOTES.

**The Annual Meeting of the Association of Edison Illuminating Companies** was held in Philadelphia, September 12th to 14th, inclusive. Papers were read on automobiles, meters, motors, lamp testing, station accounts, station practice and statistics.

**The Great Falls Power Company** is preparing plans and specifications for a water power plant at the great falls of the Potomac. The plant will contain sixteen 2000 h. p. units. The power will be used for the consolidated electric light and street railway system of the Washington Traction & Electric Company, an account of which was given in a recent issue of the American Electrician.

**The Brooklyn Institute of Arts and Sciences** has issued its prospectus for 1899-1900. In the department of electricity there are announced several interesting lectures, one of them on "Some of the More Recent Problems of Electric Lighting," by Mr. W. S. Barstow, Supt. of the Brooklyn Edison Company, and another on "The Regulation of Electric Apparatus on Electric Railways," by Mr. Frank J. Sprague.

**An Automobile Meet at Newport.**—The present rage for automobiles among the wealthier classes is well illustrated by an automobile parade which was held September 7th at Newport. Nineteen automobiles were in line, a number of which were driven by their owners, prominent in financial and social circles, who took part in a driving contest over a course obstructed with many grotesque imitations of probable obstructions, such as dummy nurse girls, baby carriages, wooden policemen, etc. The parade and contest were organized and carried through by Mrs. O. H. P. Belmont.

**The Commemoration of Volta.**—In spite of the recent destruction by fire of the buildings of the exposition at Como, Italy, the proposed ceremonies to commemorate the centenary of the discovery of the Voltaic pile were held at Como, September 18th to 23d. Very remarkable energy has been exhibited in the rebuilding of the structures burned and the re-establishment of the exhibition with new exhibits. The ceremonies were in part a National Congress of Electricians, instituted by two Italian societies, one the Italian Electrotechnical Association and the other the Italian Society of Physics.

**An Electrically Operated Mail Dispatch Tube in London.**—Some 35 years ago there was built from the general Post Office in London, England, to one railway station and one branch office an underground tube for the rapid dispatch of mail. The tube was operated for a few years by means of compressed air and finally abandoned. It is now proposed to re-equip this tunnel with electrically driven apparatus. The tube is made up of cast iron segments, the bore being about 4 ft. high by 4 ft. 6 in. wide. It is proposed to equip it with electric locomotives each capable of pulling six or seven trailers carrying about one ton of mail matter each.

**The National Export Exposition.**—On Sept. 14th the official opening of the National Export Exposition took place with appropriate ceremonies in Philadelphia. The exposition will remain open until Nov. 30, its purpose being to encourage export business between this and foreign countries, and particularly Southern and Central American states. The exhibits are of appropriate interest to representatives and visitors who are expected to attend from these lands. The electric exhibits are to a large extent of small apparatus of general application rather than large or special machinery. The exhibition is, of course, largely illuminated electrically, and different sections of the buildings and grounds are illuminated in different ways so that a comparison can be had of the effects obtained by incandescent gas, incandescent electric light and arc light methods.

**Decorative Lighting in Philadelphia.**—What has come to be known as the Avenue of Fame, on Broad Street, north and south of the City Hall, Philadelphia, was again illuminated this year in connection with the G. A. R. encampment after the same general style as last year's Peace Jubilee illuminations. Some 62 columns of staff stood 50 feet apart from Cherry Street on the north to Walnut Street on the south, the corner columns being 55 feet and the intermediate ones 45 feet in height. A line of bunting and laurel was swung between the columns, and below this decoration was a festoon of thirty-four 16-c. p. lamps. Each column at the street corners was lighted by 154 and each intermediate column by thirty-four 16-c.p. lamps, judiciously arranged to bring out the architectural features and throw a strong light on the bunting and flags. The current for the lamps was supplied by the Edison Company and the 6,000 lamps and wiring were installed by the Sawyer Electrical Company.

**A Special Train to the Street Railway Convention.**—The committee on transportation of the American Street Railway Association has arranged for a special train from the East to Chicago for the convention opening October 17th. The train will run on the following schedule:

Leave Boston 10:30 A. M. Sunday, October 15.

Leave New York 1 P. M. Sunday, October 15.

Leave Albany 4:35 P. M. Sunday, October 15.

Leave Buffalo 12 midnight Sunday, October 15.

Arrive Chicago 2:30 P. M. Monday, October 16.

The train will consist of Wagner vestibuled drawing-room sleeping cars and dining cars serving meals through to Chicago. A special rate of one and one-third fare on the certificate plan has been made, and delegates when purchasing tickets should ask ticket agent for certificate, which, on presentation at Chicago, will secure one-third fare for the return trip.

**The Department of Electrical Engineering** of the University of Illinois announces that there has been added a number of courses of study in the fields of electro-metallurgy, alternating-current working and polyphase testing, and electric lighting and power plants. The equipment of the electrical engineering laboratory is being continually increased for regular and advanced work in these branches. The four years' undergraduate course has been made elective for the last year and a half; that is, a student may elect his further work in: (1) regular electrical course; (2) electro-physical course; (3) electro-chemical course. The degree of electrical engineer is given only after completion of five years of work. The fifth year is devoted entirely to special work. The principal or primary subjects are elected from the advanced electrical engineering course; the secondary or subordinate subjects are elected from the advanced courses in mathematics, physics, chemistry and mechanical engineering. The department is in charge of Wm. S. Aldrich, Professor of Electrical Engineering.

**The Tests of Street Railway Brakes in New York City.**—On August 29th and 30th and September 7th the railroad commissioners of the state of New York began the tests of a large number of electric, air and mechanical braking devices for street cars. These tests were carried out on a line of the Metropolitan Street Railway Company's system in New York City, each maker of the device fitting it to one of the company's double truck cars. Fourteen speed and distance curves were taken of each brake submitted under emergency stop, three each at 8, 12, 15 and 16 miles per hour and two at the last speed, using sand. An ingenious automatic recording device was arranged in such a way that it could be shifted from car to car under test. It consisted of a Boyer speed recorder fitted with an electrical contact which, when the speed rose to the proper value, notified the motorman to set the brake and automatically started the time and distance recording apparatus. The latter consisted of a pencil driven by clock work in one direction over paper driven by the motion of the car in a direction at right angles to that of the pencil.

**The Study of Electrical Engineering at Drexel Institute.**—The course of instruction in electrical engineering at the Drexel Institute of Art, Science and Industry in Philadelphia is planned to, so far as possible, bring out the intimate relation be-

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tween the theoretical and practical sides of engineering, so that while the former is not neglected it is not necessary for the graduate to spend years getting practical experience and harmonizing his theoretical ideas with practical conditions. The electrical engineering course requires two years, the admission requiring either a previous study of the two years' course in Mechanic Arts or the passing of examinations on the subjects there taught. New additions have been made recently to the equipment of the laboratories, notably in the line of three-phase apparatus, in which motors and a rotary converter have been added, of sizes large enough to illustrate real engineering practice. In addition to the day courses are evening classes in applied electricity, organized along two lines, one a simple course requiring one year's time for the machinist, artisan or salesman who wishes to increase his familiarity with electrical matters, the other a more thorough course requiring two years' time. The work of both day and evening classes is in charge of Prof. Arthur J. Rowland.

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**An Electrically Wrecked Bridge.**—A novel application of electric heating was the wrecking of three spans of an old wooden bridge at Clinton, Indiana. It was desired to use the masonry piers for a new structure and the old bridge could not be wrecked by dynamite or burned without injuring them; neither could it be taken down without erecting falsework or loosened by hand and allowed to drop without great risk to those doing the work. Twenty-seven timbers, each 8 ins. square, composing the chords of each span, were simultaneously cut through a short distance from the piers by loops of No. 12 iron wire heated red hot by electric currents. The loops were weighted so that as they burned the timbers they were forced more deeply into them. Each span was brought down separately and the 54 loops of wire to each span were connected in three circuits of about 13 loops in series, these three series groups being connected in parallel across a 52-volt secondary a. c. circuit. The time required to burn through the wood until the weight of the spans carried them down averaged about one hour and a half. The current consumed varied from about 400 amperes during the first minute to 200 amperes after one hour's application, the heat from the burning wood raising the temperature of the wire and with it the resistance. The method was proposed by Mr. H. N. Mills of Clinton and proved entirely successful.

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**A Large Hydraulic and Electrical Plant in Brazil.**—Owing to the cost of fuel in many parts of South America the development of conveniently located water power promises to be most profitable. The population of many South American centers is also much greater than most people unacquainted with that continent imagine, so that the demand for power is by no means insignificant. One of the largest proposed plants is that of the Sao Paulo Railway, Lighting & Power Company, Ltd., which has been incorporated with a capital of $5,000,000, financed by the Ross, McKenzie Syndicate of Montreal and Toronto, Canada, and engineered by Mr. F. S. Pearson, the well known chief engineer of the Metropolitan Street Railway Company of New York City, and leader in electrical conduit traction work. The city of Sao Paulo has a population of 280,000 inhabitants. The plant will be located on the Tiete River, twenty-four miles above the city, where there is a flow of 150,000 cu. ft. per minute, which, with a granite dam 1000 ft. long and 35 ft. high, can be backed up to a sufficient height to give about 16,000 h. p. The flow will be carried in two of the largest pressure conduits in existence, each 3000 ft. long, with a diameter of 12 ft. The hydraulic work will cost the company in the neighborhood of $1,500,000. A contract has been signed with the Stilwell-Bierce & Smith-Vaile Company, Dayton, Ohio, for the turbines and other hydraulic auxiliary apparatus. This order calls for the supply of four special Victor turbines of 2000 h. p. each. The equipment is built to furnish the power for 100 miles of trolley lines and for many large factories. The New York office of the company desires to send to Brazil a complete line of catalogues pertaining to electrical and mechanical industries in order that the company may encourage installations for the use of its power and be posted on American apparatus suitable for such work.

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**Skin Effect in Aluminum Wires.**—Owing to the fact that the increased resistance of conductors of alternating currents, due to what is called the skin effect, increases with the diameter, fears have been entertained by some engineers that this effect would seriously reduce the efficiency of long-distance transmission lines using the great cross sections of aluminum necessary for carrying considerable amounts of current, especially on such lines as use a frequency as high as 60 cycles. The effect is, however, exactly the same as in copper lines of equivalent cross section. This is due to the fact that the skin effect expressed as a ratio of the ohmic resistance under alternating currents to that of the same conductor with direct currents depends both upon the specific resistance of the material and upon the diameter of the wire or cable. An increase in diameter causes an increase in the skin effect, which is in reality an unequal distribution of the current, by which there is a greater density of current at the surface of the wire. If, however, the specific resistance of the conductor is greater, this greater resistance tends to prevent the unequal distribution of the current. The two elements vary in such a way that if the diameter of the material having a greater specific resistance be made sufficiently large to give the same resistance in a given length to the flow of a direct current, then the tendency to skin effect, due to increased diameter, is just counterbalanced by the increased specific resistance. The skin effect, therefore, in a copper wire is just the same as it is in an aluminum wire, if the diameter of the aluminum wire is increased so that it has the same ohmic resistance as the copper wire. This relation can be seen immediately from the formula for skin effect, as the terms representing specific resistance and diameter of wire are so related that when material of a different specific resistance is used the consequent change in diameter in order to maintain the same resistance in the conductor causes no change in the value of the fraction representing skin effect.

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**The Distribution of Power to Trunk Electric Railways by Means of Gas.**—The following very significant extract from a signed statement of Mr. George Westinghouse presents a novel means of operating existing steam railways by means of electric traction, which because of its radical departure from existing practice would meet with no little skepticism but for the undoubted authority of the writer.

"Long familiarity with the electrical industry, the pipe-line transportation of natural gas in great quantities, and, during the past seven years, an active interest in the development of large gas engines, satisfy me that the economies which will result from the distribution of power by means of gas generated at central points, and conveyed in suitable pipes along the lines of railway for the operation of engines and electric generators, will be sufficient to justify the expenditure of the capital necessary for the electrical operation of railways, particularly of metropolitan and suburban lines."

Some idea of the arrangements which would be adopted on lines equipped in this way can be gained from the following extract from the same source, although not over the same signature:

"The great demand for large electric power units will undoubtedly be in connection with the operation of suburban and interurban railways and tramways. A careful inspection of the very latest electric plans would disclose the following general outline: A large, central steam power and electric generating plant, the electric generators being of the multiphase type for the generation of currents at very high voltages; a high tension system of distribution to take these currents to local stations, where there are step-down transformers which supply alternating currents to rotary transformers, which, in turn, feed direct currents to third rail or other circuits, for the operation of the motors on the railways.

"There seems to be no doubt that coal can be made into gas of a satisfactory quality at gas works suitably located, and can be taken by pipes to gas engines placed in the positions corresponding to the sites of the rotary transformers of the foregoing plan, for a capital expen-

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diture greatly below that required for an equivalent steam boiler and engine plant. The cost for fuel per electrical horse power so delivered should not exceed 50 per cent. of the cost of the fuel for generating electricity by steam for similar service."

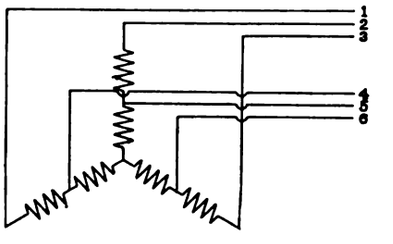
**A Proposed Municipal Transmission Plant for Lighting Chicago.**—The Chicago drainage canal has at some points a series of falls which will make available a considerable amount of power. It has been proposed that the city should utilize this power for lighting the streets.

At a recent conference of engineers to discuss the subject, Mr. F. B. Badt of the Meysenberg & Badt Company, assuming a line of pressure of 40,000 volts, estimated the cost of installation, less the pole line, permanent works and right of way, as $45 per horse power, delivered at the sub-station—the city terminal of the pole line. The approximate cost of the pole line he put at $9 per horse power, which would bring the cost of the hydraulic and electrical installation up to $54 a horse power. Assuming that the initial horse power to be transmitted was 20,000, he estimated the cost of the installation, exclusive of the dam, tail race and water wheel pits, at $1,080,000. Then, allowing $400,000 for the cost of the distributing plant in the city, and adding $20,000 for incidentals, he estimated the cost of the plant would be about $1,500,000.

He placed the operating expenses, interest on the investment and depreciation of plant at $12.25 per horse power per year. On the assumption that the lessee of the water power would pay the district an annual rent of $10 a horse power, he showed it would cost him $14 a horse power to deliver it to his customer; adding $12.25 to this figure, Mr. Badt estimated that the cost of a horse power a year would be about $26.25 at the point of consumption.

City Electrician Ellicott said that Chicago to-day is lighting 3,000 arc lights from three electrical plants; that it would take 16,000 lights to light the built up parts of the city, requiring about 14,000 horse power. The cost per horse power per year to the city for electric lighting by a steam plant is $34.37, exclusive of interest on the investment and depreciation of machinery. He estimated that the city by building a modern steam power plant to light 16,000 arc lamps could get its horse power for $27 per year. To this he added $8 a horse power per year for interest and depreciation, bringing the cost up to $35, on a working basis of ten hours and thirty-seven minutes each day. He estimated that if the city were to install a hydraulic and electrical plant to light 16,000 arc lights, the expenditure would amount to $1,980,000; adding to this the estimated cost of $1,200,000 for constructing a dam, tail race, etc., would bring the aggregate cost of the whole plant up to $3,180,000. On this basis, he said, the city could afford to pay the sanitary district $9 a horse power per year at the water wheel to bring the cost per horse power of the hydraulic-electrical system up to the cost of the steam electrical system.

**A Simple Two-Phase System of Secondary Mains.**—On the distributing network of the Hartford Electric Light Company, a description of whose plant appeared in the July issue of the American Electrician, there is in use a simple means of distributing with a minimum number of wires the two-phase currents for both lights and motors. The secondary mains are three-wire for lighting and two-phase for power, largely underground and supplied in districts by manhole transformers. Each manhole has two transformers, one for each phase; each transformer being tapped out at its central point for the neutral of the three-wire 220-volt network. The secondaries of the two transformers are shown at A and B in the accompanying diagram of connections. One outside terminal of A is connected to one outside terminal of B, and in each direction four wires are carried. It will be noticed that to the right the upper three wires are those of the three-wire single-phase circuit from transformer A, and the lower wire coming from transformer, B, with the wire next above it gives a pressure of 220 volts of the other phase to motors in that direction. The neutral of transformer A is not carried to the left, while that of transformer B is, and all lights in this direction are supplied from the three-wire system of the latter transformer, while in this direction also one wire serves commonly as one outer of the three-wire system and as one side of the secondary of the other phase. Thus four wires serve to give a three-wire lighting and a two-phase motor distribution and the lights are approximately equally divided between the two phases. The neutrals are, of course, not connected in to the motors, which run at 220 volts on each phase and are wired on the two-phase three-wire principle. It is obvious that there is between the upper and the lower wires going out in each direction an electromotive force consisting of the vectorial resultant of the two 220 volts which amounts to about 310 volts, but this increased pressure is no particular disadvantage on low-tension circuits. It is also obvious that the wire used commonly by both phases gets an increased current but not sufficiently so to materially affect the regulation. The system has proven perfectly satisfactory.




THE CONNECTIONS OF SECONDARY NETWORKS FOR THE DISTRIBUTION OF TWO-PHASE POWER AND THREE-WIRE LIGHTING ON FOUR WIRES.

**Marconi in This Country.**—Through the efforts of some of the leading daily papers Signor Guglielmo Marconi, with several assistants, is now in this country to take charge of the reporting of the international yacht races by means of wireless telegraphy. The transmitter apparatus has been installed in the pilot house of an ocean-going steamer, the Ponce, there being two receiving stations, one on the Navesink Highlands and the other on the cable ship Mackay-Bennett, which is located near Sandy Hook, some 20 miles from the greater part of the course, and connected with the shore by cables. It is also reported that the Naval Department of the United States Government has arranged with Signor Marconi to visit Washington and confer with Rear Admiral Bradford, Chief of the Bureau of Equipment, concerning proposed experiments to be carried on by officers of the United States Navy in wireless telegraphy. Some details of the apparatus may be of interest. Each station has a vertical conductor 150 ft. high, sufficient, it is estimated, for transmission over seventy-five miles, or twice the distance which will have to be bridged. The transmitting battery consists of ninety-eight dry cells, connected fourteen in series, and seven in multiple, and in parallel with eight storage cells in series, this arrangement being intended to give six amperes at about seventeen volts. The coherer consists of a glass tube about two inches long, in which two silver plugs a quarter of an inch long are tightly fitted and separated from each other by about one-thirtieth of an inch, the gap between them being partially filled with a mixture of nickel and silver filings, these metals having been found to be the most sensitive and reliable after a long series of experiments. The coherer is exhausted to a vacuum of four millimeters. In circuit with the coherer is a single dry cell and a telegraphic relay of the ordinary type. This relay is used to close the circuit of a local battery, which works a Morse writing instrument and also an electric bell hammer, which strikes the coherer a smart tap to restore it to its normal high resistance after it has received an impulse from the distant transmitter. To protect the coherer from the too powerful effects of the local transmitter the whole receiver is enclosed in a metallic box.

**An Organization of Dynamo and Motor Manufacturers.**—At the invitation of the Cutler-Hammer Manufacturing Company a meeting of representatives of the dynamo and motor manufacturers of this country was held in Chicago on the evening of Sept. 19th, another meeting being held the day following. The meeting was called for the purpose of forming a permanent organization. Although the purpose of the organization is not stated it is presumably to preserve more amicable relations in the competition for trade.

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### Double Current Generators for Edison Stations.

The advantages of high-tension polyphase transmission now being recognized in connection with low-tension direct-current distribution, the problems involved in the generation of the high-tension power demand attention. In certain instances—where the generating station is within a district of congested loads—the generation of the polyphase currents is best combined with that of the low-tension power, especially if the daily peaks of the two loads do not occur at the same time, and one set of machines can be used to carry the peaks of both loads. Such an instance occurs in the system of the Chicago Edison Company, where so-called double current generators have been adopted, a description of which appears in the first article in this paper.

A peculiarity of these machines is that they are practically identical with rotary converters. Indeed the three-wire multipolar units, direct coupled to the steam engines and used for generating both kinds of current in the Harrison Street Station in Chicago are termed on their name plates "rotary converters," while the 4-pole machine not engine driven, but used only as a rotary converter, is styled a "three-phase continuous generator."

Where machines are used in this way for the simultaneous generation of both kinds of current, and particularly when two of them are coupled to the same shaft, some peculiar conditions arise in the problem of voltage regulation. Since the two dynamos of one unit are rigidly coupled to the same engine they cannot divide their a. c. load as do ordinary alternators according to the adjustment of the governors of their prime movers. Neither can the division of the a. c. load between them, when thrown in parallel on the a. c. side, be affected by varying the relative field excitation, since any difference between the a. c. voltages of the two would be immediately and automatically corrected by the interchange of wattless currents. Apparently the division of the load is determined once for all by the setting up of field rings of the two machines.

The a. c. sides of the positive and negative machines of one unit cannot of course be electrically connected in parallel as they are at different direct-current potentials, so they are in this plant magnetically paralleled by being connected to coils in the same step-up transformers. Even the machines of different units are not electrically paralleled on their a. c. low-tension sides as they might possibly be, but each unit is supplied with its own step-up transformers, the paralleling being done on the high-tension side.

Naturally some means must be provided to give an adjustment of the a. c. voltage independently of the d. c. voltage, and this is accomplished by means of induction regulators, one of which is inserted in the low-tension leads of each dynamo. A complete description and diagrams of the various regulating and controlling devices will be found in the article referred to.

### Floor Outlets in Large Offices.

The business man of the present day as a rule must have on his desk an electric light, a desk telephone, at least one push button and generally more, and in many cases one or more buzzers or bells connected with distant push buttons. Since the lighting wires must be isolated from the others, and the telephone companies generally prefer to have their wiring separate, this requires as a rule outlets at each desk from three interior conduits: one for the lighting, one for the telephoning and one for the signaling conductors. Where the desks are in small offices, adjacent to the walls, the problem is a simple one, as wall outlets can be fixed at a convenient height behind them, but where a large number of desks are in one large office room the case becomes more complicated.

In such offices it is generally now considered objectionable to bring down cords from the ceiling outlets or electroliers for the lighting service, so that all three classes of wiring must be brought up through the floor. Where the exact location of each desk room is known before the interior conduits are installed, the outlets can be properly located, but as a rule the layout of the office is not known or the plans are changed when the furniture is put in place. In this case at least some of the outlets are bound to come in passageways or under the feet of the persons sitting at their desks, and the wires leaving them will have their insulation

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rapidly worn away by the constant tramping, or if made extra heavy will be likely to trip those walking past them. A case of this kind is described in the account of the wiring of the offices given in the second article in this issue.

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Some better fixture is imperatively needed for such cases. The only solution that suggests itself with the apparatus now on the market is the use of many outlets scattered over the floor, one of which is bound to be in a suitable location for each desk, no matter what the arragement of the furniture may be, this outlet to be used and the others to be left closed.

---

**The Heating of Enclosed Motors.**

The occasional use of street railway motors for stationary work in exposed locations has proven so satisfactory that a demand has arisen for enclosed motors which has compelled practically all manufacturers to place on the market a line of such machines. This demand exists in spite of the fact that such a machine costs considerably more than an open motor of the same power. This is due to the fact that the enclosed motor gets no ventilation, and therefore cannot dissipate readily the heat generated on heavy loads, and must be rated at a very low load. The result is that a motor which will, when open, safely carry 15 h. p. will, if enclosed, reach the temperature limit with a load of about 10 h. p., and its rating when enclosed must be correspondingly reduced.

---

The only way in which the heat is dissipated from an enclosed motor is by radiation and convection from its exterior surface, there being no circulation of air through its parts. The surface must therefore be made larger if the motor is to be enclosed in order to carry away the heat, which otherwise would be dissipated by ventilation. In building an enclosed motor the armature, the commutator, the field magnets, etc., are made larger and correspondingly more expensive, solely to get an increased surface of the yoke ring and covers. As a rule the increased size gains nothing in the direction of a reduction of the heat generated within the machine, as is shown by the fact that enclosed motors are generally less efficient than open ones.

---

It would seem to be a far preferable plan to make the exterior of the motor with deep corrugations similar to those used for dissipating heat from enamel rheostats or theatre dimmers, or even more similar to the deeply corrugated rings of the cylinders of small unjacketed gasoline engines, such as are used in automobiles. These corrugations would greatly increase the superficial area of a given machine without increasing the size of its internal parts, and would almost correspondingly increase the heat which could be dissipated at a given temperature. Motors with deeply corrugated yoke rings of this kind are made by one enterprising house in Italy, and American manufacturers who now make their motors with practically a minimum ratio of surface to volume would do well to consider this plan.

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**Long Distance Transmission of Power by Means of Gas.**

The attention of the reader is called to the remarkable signed statement of Mr. George Westinghouse, reprinted on page 472 of this paper, concerning the distribution of power to the sub-stations of long distance interurban or trunk line railways. The statement is made with a positiveness which, coming from such an authority, must carry great weight, that—where power is derived from fuel and transmitted long distances and distributed as direct current—it is preferable to drive the direct-current machines in the sub-stations by gas engines supplied by pipe lines from a central gas producing plant rather than to drive the same machines as rotary converters supplied by a polyphase transmission line from alternating current generators driven by the engines at the central source of power.

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In other words, a central gas producing plant with pipe lines to sub-stations at distances of many miles is considered preferable to the transportation of the fuel in the solid form to these sub-stations and its use in a local gas producing plant at each. Furthermore, the gas pipe line from the central gas plant to distributed gas engines is considered preferable to centralized engines, generators, high-tension lines and step-down transformers.

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It is interesting to see if the same conditions, which warrant the forecast of this revolutionary departure in power transmission for railroad purposes, apply to other lines of long distance work. Naturally they do not apply to the greatest number of long distance transmissions, viz., those driven by water powers. It has often been proposed to erect central power generating plants in the coal fields, especialy those of Pennsylvania, where enormous piles of low grade practically valueless coal, termed culm, now lie waste, but might be profitably utilized under boilers located near them, these boilers driving plants from which the power could be transmitted at high pressure to distant centers of population. If the opinion of Mr. Westinghouse is carrect (and his experience with all the factors involved must give it great weight), such transmissions would be better effected by generating producer gas from waste fuel and transmitting this by means of pipe lines to the distant centers of power distribution. All that has of late hindered the utilization of the enormous piles of waste fuel has been the fact that the loads are in the neighborhood of 100 miles away, too far distant for profitable transmission at voltages now available. The use of gas pipe lines may extend the range of profitable transmission far beyond that available electrically, in which case this utilization of a hitherto wasted bi-product may soon be realized. The existing transmission of natural gas from the gas fields in Indiana over considerable distances to Chicago gives an idea of the possibilities of transmission of this kind.

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In central-station work also it is becoming customary to centralize the generation and transmit at high tension to rotary converters feeding the distributing system. The centralized generation is largely for the purpose of locating the plant on the water front where condensing water and cheap fuel can be obtained. If gas engines supersede steam engines for central station work, as they promise to do, the condensing water advantage of the water side location will vanish, and the fuel advantage can be retained by locating the gas producing plant at such a point and distributing the engines among the sub-stations. In the case of central-station distribution, however, there is, as a rule, no such great cost of transmission lines and great loss therein as in the case of such long distance work as that for which Mr. Westinghouse advocates gas engines, viz., suburban and interurban railways. However, there is apparently good reason to fear that large generating plants feeding rotary sub-stations may be shut down and superseded by gas engines driving the rotary converters direct.

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## THE CONSTRUCTION OF SOME HANDY COMMUTATOR TOOLS.

BY ALTON D. ADAMS.

Direct current dynamos and motors have now come into very general use, exceeding in number, perhaps, steam, gas and oil engines combined. As is well known these electrical machines are subject to mechanical wear at only the bearings and the commutator, which have to be replaced from time to time. The very general demand for dynamos and motor repairs has been met to some extent by electric repair shops that have come into existence at many points through the country, but aside from these there is hardly a regular machine shop of any size that is not constantly called on for more or less work on the worn parts of dynamos and motors.

As bearings in electrical machines are usually fitted with bronze bushings, with standard reamed holes, well equipped machine shops are usually in position to make these parts, but in the matter of commutators there is not one regular shop in fifty with the simple tools necessary for their renewal, and the average machinist has but slight conception of how this work must be done to insure satisfactory results.

In electrical repair shops there are usually some tools for handling commutator work, but they are frequently of the crudest kind and such as to require too much labor, and even then lack certainty in results. Some even among dynamo and motor manufacturers lack the few and simple tools necessary to insure first-class commutator construction with a minimum of labor. As usually constructed, a commutator contains a number of copper "bars" or "segments," separated from each other, and the clamping parts by mica strips and rings. These bars are parts of true circular sectors, though not of the exact circle of the commutator surface, and are held, with the intervening mica strips, by a sleeve and clamps.

Some of the main requirements of commutator construction are that each segment be insulated or free from metallic contact with any other or the sleeve and clamps, that each segment be so firmly held that the forces of expansion, due to heat when the machine is in use, shall not alter its relation to the other segments, and further that the relative position of segments and mica strips shall remain the same after the commutator has cooled.

Were all parts of commutators metal, the above requirements would make careful work necessary, but as each segment must be held entirely by contact with mica, the problem is much more difficult, in fact, it has required more study and experiment than any other mechanical question that electrical manufacturers have had to meet.

Mica has come into very general use for commutator insulation because of its high insulating properties, non-injury by heat and power to sustain great pressures with but small compression. On dynamos and motors of moderate capacity in common use the number of commutator segments varies from six or eight to about two hundred according to the purpose and capacity of the machine, the most common numbers of segments being from twenty-four to one hundred.

As for every segment there must be a strip of mica, in addition to the mica rings, the number of separate parts that must be held in their exact position in a commutator will vary from fifty to about four hundred in machines of moderate capacity and common use. In order to hold so many pieces of materials, to a large extent contrary as to their qualities, rigidly together, it has been found

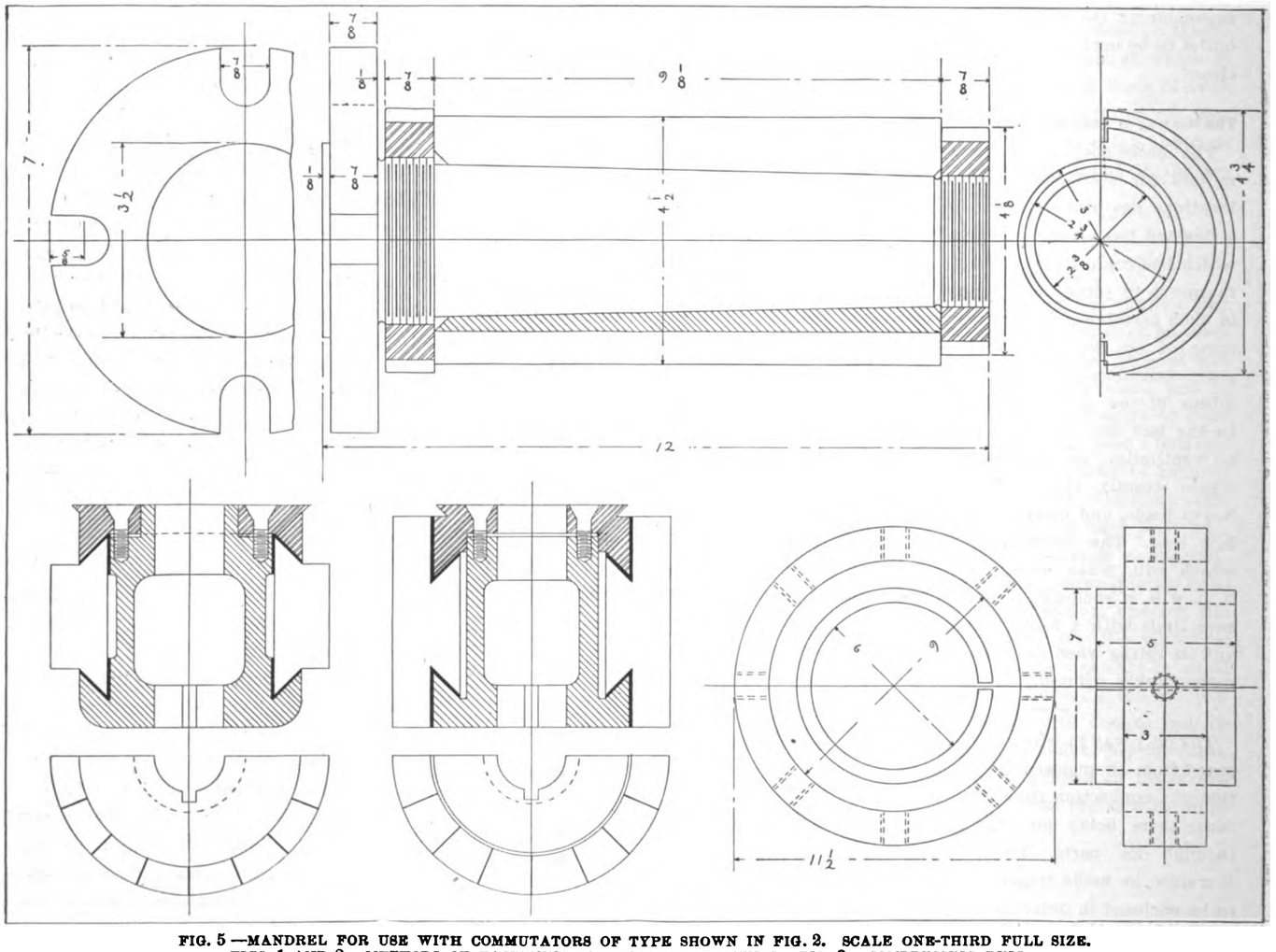



FIG. 5.—MANDREL FOR USE WITH COMMUTATORS OF TYPE SHOWN IN FIG. 2. SCALE ONE-THIRD FULL SIZE.
FIGS 1 AND 2.—METHODS OF FASTENING COMMUTATOR SEGMENTS. FIG. 3.—COMPRESSING RING.

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necessary to assemble them with great pressure, and then set the permanent clamps as tightly as possible before the external pressure is removed.

The two most common and successful methods of clamping commutators are shown in Figs. 1 and 2, the solid black lines in each case representing the mica strips and rings. The better class of segments are forged or of drawn stock, so that no labor is required on the sides before assembly in the way shown. As soon as assembled it is necessary to compress and hold the segments securely so that the surfaces which come in contact with the mica rings may be machined.

A method to compress and hold the segments, common in many electric repair shops, and with some manufacturers, employs a solid forged ring turned on the inside to the diameter which the segments are estimated to have when compressed, and tapered slightly at one edge so as to start easily over the segments. In the correct use of this ring it should be forced over the segments with a pressure of some tons, as this source of pressure is the only one to bring the segments and mica strips solidly together. To do a good job with this solid ring a hydraulic or large screw press is necessary, and in many cases machine and repair shops are without either of these presses, so that the ring can only be forced on and off the segments with a hammer, a very unsatisfactory method. A serious objection to this solid ring method is that it is very hard to estimate the exact diameter to which the ring should be turned in order to properly compress the segments, and the trials to see how hard the ring crowds on all take time. Again a solid forged ring must be had for every size of commutator, even though they vary by only a small fraction of an inch in diameter, and there is great temptation when a ring goes on too easy to let it go as "good enough." To do away with the necessity for presses, also forged rings for every commutator, save time and insure means for the desired compression in every case, the tool shown in Fig. 3 is now much used.

This tool consists of two rings, the outer a solid forging and the inner an iron casting, split along one side so that its diameter may be slightly changed.

The outer forged ring is fitted with six, eight or more radial set screws, which bear upon the inner split ring. The commutator segments and mica strips having been assembled in circular form, the split cast-iron ring, having been turned as near as possible to the correct diameter, is pushed over them and pressure applied by means of the large set screws in the forged ring. Any desired pressure can be obtained by the combined action of the heavy set screws, the split ring readily conforming to the slightly reduced diameter of the segments. The work can also be done much more quickly than when a solid ring and press are used. It is not necessary to have one of the above tools for each size of commutator, as only the inner cast ring need be changed until the commutator diameters vary by as much as three inches, so that the forged ring becomes either too small or so large as to be unhandy. In this way two or three forged rings will cover a large line of commutators, while the cast ring for each commutator is cheaply and quickly made.

When the segments are securely clamped in the ring the next step is to turn up the surfaces to which the mica rings transmit the pressure of the permanent clamps. In most machine and electric repair shops the lathe chucks are the only means for holding the clamped commutator segments while the surfaces at each end are machined, and here comes a waste of time and inaccurate results due to the effort, after one end of the segments has been turned up to reverse them in the chuck, so as to machine the other end in line with the first. The tendency with work done in this way is to force the permanent clamps slightly out of line with each other, and this may result in loose segments at some point in the commutator. Proper expansion mandrels, as shown in Figs. 4 and 5, not only enable the finished surfaces at the two ends of the segments to be brought practically into line, but also save much time on the work.

Fig. 4 shows a mandrel adapted for use with segments of the type in Fig. 1, where there is no undercut work to be done, while the mandrel of Fig. 5 is more convenient for undercut segments. The mandrel of Fig. 4 mounts in the usual way on lathe centers, has a taper of one in twenty-four, is fitted with cast-iron expansion sleeve and a screw collar at each end, to force the sleeve on and off. The cast-iron sleeve should be cut entirely through once along its entire length, and nearly through, say, to within one-fourth or three-eighths inch at three or more other points, that it may expand as evenly as possible when forced onto the mandrel.

A sleeve for this mandrel should be turned outside to correspond with the inside diameter of the commutator segments it is intended to mount, and if very accurate work is desired the inside of segments should be turned out before mounting them on the expansion sleeve, though some makers think this unnecessary. When the segments are mounted on the sleeve this latter is expanded by forcing it on the mandrel with the screw collar, and the ends of segments in Fig. 1 can be turned up without changing their position.

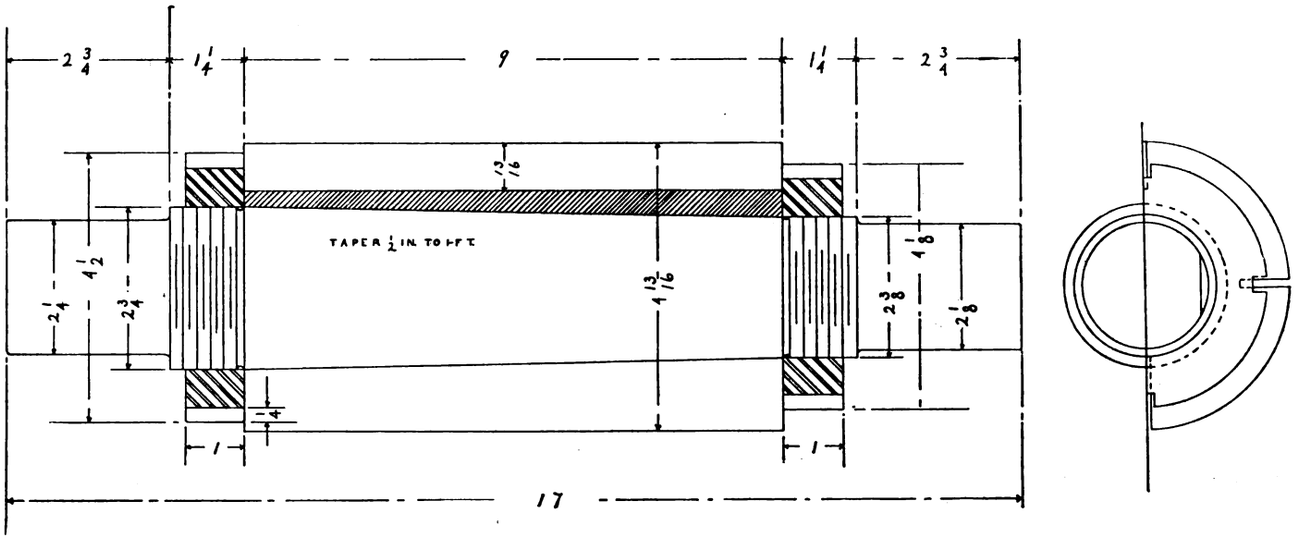



FIG. 4.—MANDREL FOR USE WITH COMMUTATORS OF TYPE SHOWN IN FIG. 1. SCALE ¼ FULL SIZE.

The segments shown in Fig. 2 can also be turned on the above mandrel, but the work on the undercut is done at a disadvantage and much time can be saved by the use of the mandrel of Fig. 5. This mandrel, like the other, is on a taper and fitted with expansion sleeve, but one end is forged into a flange, adapted to bolt to a face plate and allow free access to one end of the commutator segments, so that the undercut can be made quickly. One end of the segments being finished, they are forced off the mandrel with the sleeve by the screw collar, and then put on again reversed and the other end finished. There is, of course, no reason to take the man-

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drel from the face plate until both ends of the segments are finished, so that time is saved and the finished surfaces brought very nearly in line. Quite a number of expansion sleeves can be used on the same mandrel for different commutators, so that two or three mandrels will be enough for a factory turning out a fair line of machines.

Having turned up the ends of the segments, it is next necessary to mount them on the insulating rings and permanent clamps. As segments are held only at the finished surfaces, it is necessary that each make solid contact with all of the mica rings, as the side pressure of the other segments is not sufficient to prevent motion either up or down. The double ring clamps are of special value when the segments are to be brought to a firm bearing on the mica rings, since, when necessary, the set screws can be let up a little in order to allow the segments to slide over the horizontal mica rings, and then set up until each segment beds firmly on the mica. The permanent clamps once in place, the outside rings are removed and the surface of the segments finished up, first by turning with a diamond-pointed tool and later with a single cut file or the finest grade of sand paper.

It may be well to add the oft repeated warning that emery cloth should never be used on a commutator, as the emery sticks in the copper.

The above simple and inexpensive tools will multiply several times the amount of commutator work a man can turn out daily with the devices now common in some shops devoted to the repair and even the manufacture of electrical machinery.

## AMERICAN TELEPHONE PRACTICE.

### TESTING.*

BY KEMPSTER B. MILLER.

One of the principal uses of the galvanometer in line testing is in the measurements of insulation resistance. The insulation resistance of any line or conductor is the joint resistance of all the leaks from the line to the ground or to other conductors. On a pole line every insulator forms a leak to earth, and on a line having 40 poles to the mile there would be 40 such leaks in parallel. The insulation resistance of a line as a whole varies inversely as its length, if the insulation is uniform. Evidently, a line two miles long would have one-half as great an insulation resistance as a similar line one mile long, because on the latter there would be only half as many leaks as on the former. In general it may be stated that a line n miles long will have only $\frac{1}{n}$ as great an insulation resistance as a similar line one mile in length. In order to obtain a standard of insulation resistance independent of the length of the line, it is convenient to express the insulation resistance as so many megohms per mile. The insulation resistance per mile is found by multiplying the insulation of the line as a whole by the length of the line in miles.

In order to measure the insulation resistance of a line the constant of the galvanometer is first taken and the known resistance is cut out of circuit and the line insulation resistance substituted for it. Assuming that the insulation resistance to be measured is that of a wire in a cable, the terminals of the circuit which should be connected with the resistance to be measured, will be connected one with the wire and the

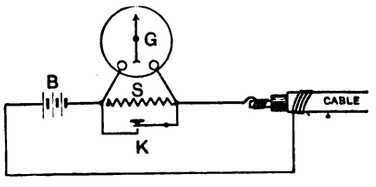



FIG. 1.

other with the sheath of the cable as shown in Fig. 1. Care must be taken that the wire being measured is carefully insulated from the sheath at the other end of the cable. The shunt, S, is then cut out of circuit in order that the full current may pass through the galvanometer. Before completing the circuit with the cable conductor and sheath, however, the key, K, should be closed in parallel with the galvanometer, in order to prevent the rush of current that will take place in charging the cable, from causing the needle to give too violent a kick. After a short time the key is opened and all of the current diverted through the galvanometer. The galvanometer then receives only that current which leaks from the core of the cable to the sheath through the insulation. Under these circumstances a certain deflection will be noted, and by comparing this de-

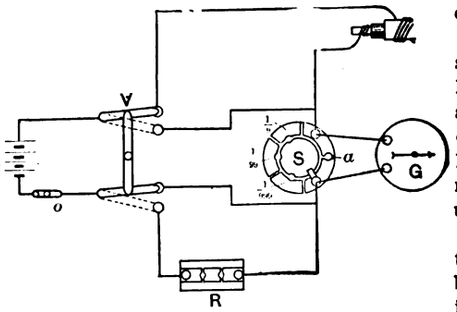



FIG. 2.

flection with the constant already obtained the value of the insulation resistance in megohms is readily determined.

To illustrate, suppose that a deflection of 75 scale divisions is obtained with the apparatus connected as in Fig. 1. If the constant is 20,000, as already determined, we know that the insulation resistance must be 20,000 divided by 75, or 266 megohms, thus indicating that the total insulation resistance of the cable is 266 megohms. That this is true is evident from the fact that the constant, 20,000, represents the number of scale divisions deflection that would be obtained were only one megohm in the circuit. The deflections are inversely proportional to the resistance in the circuit, and therefore the total insulation resistance is equal to the deflection through one megohm divided by the deflection through the insulation resistance, or 20,000 divided by 75. To sum up these operations:

1st. Obtain the galvanometer constant or deflection obtained when the galvanometer in series with one megohm resistance is subjected to the potential of the battery. 2d. Find the deflection obtained when the galvanometer and insulation resistance in series are subjected to the potential of the battery. 3d. Divide the constant by the deflection obtained through the insulation resistance, the result being the insulation resistance of the cable expressed in megohms. 4th. To find the insulation resistance per mile, multiply the total insulation resistance by the length of the cable in miles.

In Fig. 2 is shown a convenient arrangement of connections for making insulation tests. In this, B is the battery of say 50 cells, R the 1/10 megohm box, S the shunt box, G the galvanometer and V a convenient switch for throwing either the 1/10 megohm box or the line insulation into circuit with the galvanometer and battery. When the levers of the switch, V, are in the position represented by the dotted line, the circuits are those for taking constant of the galvanometer, and when in the position shown by full lines, the circuits are those for obtaining the deflection through the insulation of the cable. Various forms of keys for changing the direction of the battery current through the galvanometer, and for performing other switching operations with the greatest possible convenience, are obtainable, and form an important part of all testing outfits. The scope of this work will not permit of their detailed description.

In making the insulation tests the resistance of the lead wires to the cable or line need not be taken into account. It is a matter of the greatest importance, however, that these wires are perfectly insulated from each other. It is a very easy matter in testing of this nature to measure the wrong quantity.

One very important matter in connection with insulation tests has not yet been spoken of. When the reading is being taken, with the cable or line insulation in circuit, it will be noticed that a maximum deflection is obtained at first, and that this gradually diminishes, as though the insulation resistance were increasing. This is due to what is called electrification, a phenomenon that is not very thoroughly understood. When the electromotive force of the battery is first applied to the cable or line, there is a sudden rush of current, due to the charging of the conductors. The charges, however, apparently soak in to the insulation to a slight extent, thus allowing more current to flow to the conductors. After the first rush due to the first charging of

* From a book to be published by the American Electrician Company.

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the conductors, there is still a flow of current, due in part to this soaking in, and in part to the actual leakage through the insulation. It is the current due to the latter that we are concerned with in insulation measurements, and therefore we must wait till the soaking-in process ceases, when the flow of current will be practically constant, being that through the insulation. In nearly all telephone-testing work, one minute is allowed for electrification, after which the reading is taken of the deflection. When one is thoroughly familiar with his instruments he may often, where great accuracy is not required, estimate what the deflection at the end of one minute will be, by watching the deflection for 30 or 40 seconds. This method saves time, but must be used with extreme caution.

With a constant of 20,000 a reading taken on a wire in a piece of good new telephone cable, one-quarter mile long, would probably show a deflection of 8 or 10 scale divisions upon the closure of the key. This would decrease to about 6 scale divisions in 2 seconds, and to about 2 scale divisions in 30 seconds, after which it would remain constant. The reading of 2 divisions at the end of the minute would indicate an insulation resistance of

$$\frac{20{,}000}{2} = 10{,}000 \text{ megohms}$$

or 2500 megohms per mile.

As an example of a deflection on a wire in a representative cable the following is given:

Dry paper cable, ¾ mile long, two years old. Galvanometer constant 22,000: Readings, 12-15-15-10-10-15-15-15-13 scale divisions.

## INTERIOR WIRING.

### OUTLET BOXES.

BY CHARLES E. KNOX.

One of the recent additions to the requirements of the National Board of Fire Underwriters was that in regard to the use of outlet boxes. Previous to that time they were used in the larger and more important installations, but in the majority of cases their use was dispensed with. The rules passed by the National Board covering outlet boxes are as follows:

Rule No. 25d. (Interior Conduits). Must be equipped at every outlet with an approved outlet box.

Rule 25e. Metal conduits, where they enter junction boxes, and at all other outlets, etc., must be fitted with a capping of approved insulating material, fitted so as to protect wire from abrasion.

The wisdom of passing the former rule is beyond question; the latter is open to discussion. We will consider this more fully after describing outlet boxes and their advantages, in a general way, and after that the various forms and types of outlet boxes.

An outlet box is a metal box, usually in two parts (box and cover), placed at an outlet, to provide a terminal for the conduits, and also a space for making the connections between the branch circuit wires and the outlet fixture or appliance.

Their advantages are: 1. That in no other way can such a satisfactory terminal for the conduits be obtained. 2. The connections between the fixture and the branch circuit wire can, with the use of outlet boxes, be made in a space protected from plaster, dirt, etc. 3. By their use it is possible to make a neat finish, with plaster, wood, etc., around the outlet opening, which would be impossible without their use. 4. The boxes being insulated inside, the possibility of "ground" or "short circuit" is greatly decreased at the points where these troubles are most apt to occur. 5. By their use, particularly in the case of side outlets, a suitable support for the fixture is more easily obtained.

As to the rule of the Fire Underwriters requiring "a capping of approved insulating material fitted so as to protect the wire from abrasion," it would seem to be both unnecessary and undesirable in a properly designed outlet box. If arrangements are made in the design of the outlet box to receive the conduits in a proper manner and to prevent the conduit from coming beyond a proper distance into the box, it would seem impossible for any abrasion or injury to the wire to occur, because owing to the confined limits of the box it would be impossible to bend the wire sharply over the end of the conduit. If, however, no means be used in the outlet box to prevent the tube from projecting more than a slight distance into the box, it is easily conceivable that such abrasion of the wire may take place. Where the tube is allowed to project any considerable distance into the box, it is apparent that in order to bring the wires from the opening of the tube to the proper point (presumably the center of the outlet box opening), friction of the wire against the tube and consequent injury to the wire are very apt to happen. It would seem that the proper way to prevent any such abrasion to the wire insulation would be to adopt means to prevent the conduit from projecting into the outlet box beyond the proper point. Another objection to the use of this "capping," or "outlet terminal," is that the outlet box would probably have to be increased in depth to receive it, which would be objectionable.

The first iron outlet boxes used with iron-armored conduit consisted of a hollow iron casting, in one piece, about four inches square and one and a half inches deep, with an opening in the front face, and having one of the sides open to receive the conduits. If conduits entered the box at any other side, openings in the box were made to receive them. This box had many disadvantages. In the first place it was clumsy; it made no provision for tubes entering it on more than one side, and it was necessary to fill up the large opening around the tube to prevent plaster and other materials from falling into the box itself. It had other disadvantages, which will be apparent from the discussion of the present forms of outlet boxes given below.

All the outlet boxes now manufactured may be roughly classified (like men's clothing) in two groups, viz., first, "ready-made," and, second, "made to order." Under the first head are included those forms of boxes usually designated universal outlet boxes, in which provision has been made so that an opening may be made more or less readily in any part of the box so that, no matter in what direction the tube comes, a corresponding opening in the box may be made more or less readily without drilling. The other type of box is one in which openings are already made at certain points for the conduits to enter. Let us now consider the various forms of both types of outlet boxes in detail.

Figs. 1, 2 and 6, page 480, drawn steel outlet boxes of the first (universal type). Figs. 3, 4 and 5 show cuts of drawn steel boxes which may be used as universal boxes by ordering boxes of the designs as shown, but with the maximum number of holes and having all the holes plugged with steel plugs.

Figs. 7 to 15, inclusive, show boxes each of which is designed for a particular case, and is not intended to be used under any other conditions than those for which it was designed.

The advantage of the universal type is apparent. When these boxes are used it is only necessary to state in ordering whether round or square boxes are wanted, and whether for gas and electric fixtures or electric fixtures only. Again, in these boxes the tubes may be brought into the box from any side, as it is possible to make an opening in any of the four sides or in the back; also, if the work be changed or if outlets be omitted, the boxes are good for future work, as they can be used under pretty nearly all conduits. Their disadvantage is the same as that which is, and always will be, the objection to all universal tools, namely, that they are admirably adapted for all cases but very poorly suited to any one particular case. It is always necessary in making a thing suitable for all cases to compromise several points in order to make the tool or appliance suitable for all conditions.

The advantage of the other type of boxes is that each box being designed for a specific purpose, it is especially arranged for those conditions, and much neater and better work is attained by their use, their disadvantage being that a little more trouble is involved in ordering. We will now describe in detail each of the boxes shown in the cuts.

Fig. 1 shows a square box and cover having two plugged openings on each of two opposite sides and one plugged opening on each of the other sides. The openings in the boxes have threaded sleeves to receive the conduit. It is questionable whether threading the sleeves is necessary. It certainly adds considerable to the cost of installing the conduit in the box, as it is necessary to put a thread on the conduit and screw the conduit into the box. Each of the plugged openings in this

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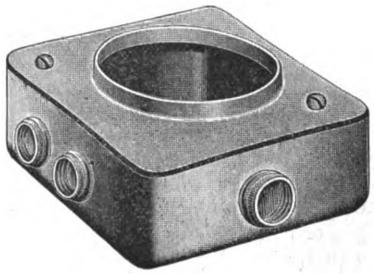


FIG. 1.



FIG. 2.

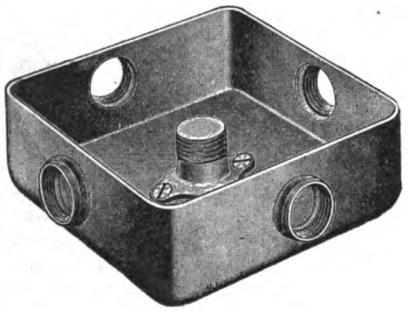


FIG. 3.

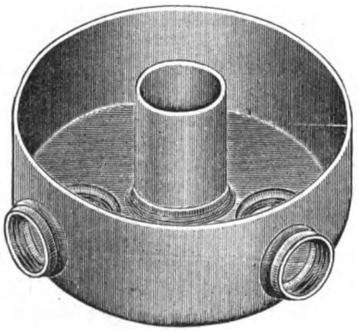


FIG. 4.

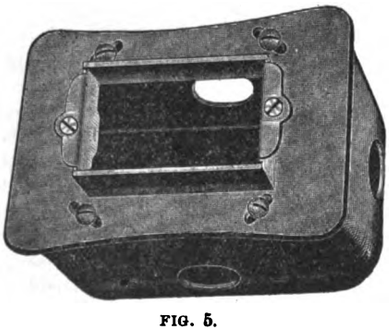
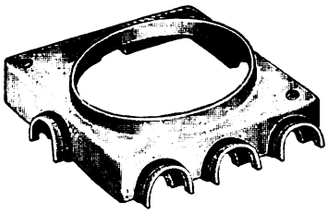


FIG. 5.



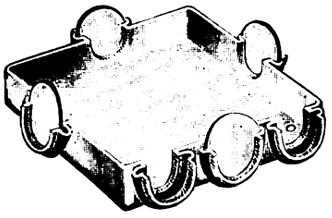


FIG. 6.

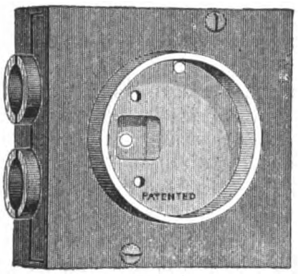
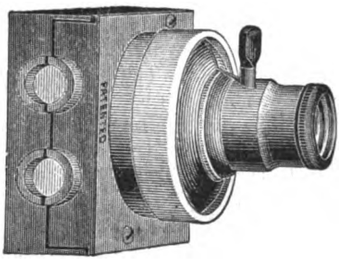



FIG 7.




FIG, 8.

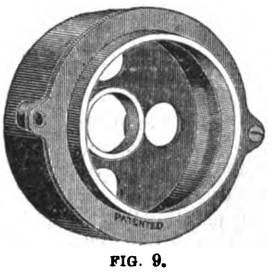



FIG. 9.

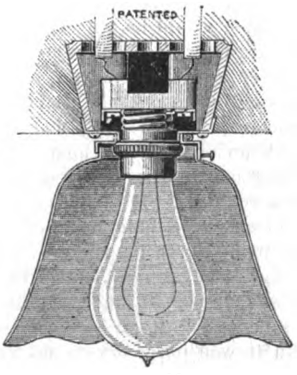



FIG. 10.

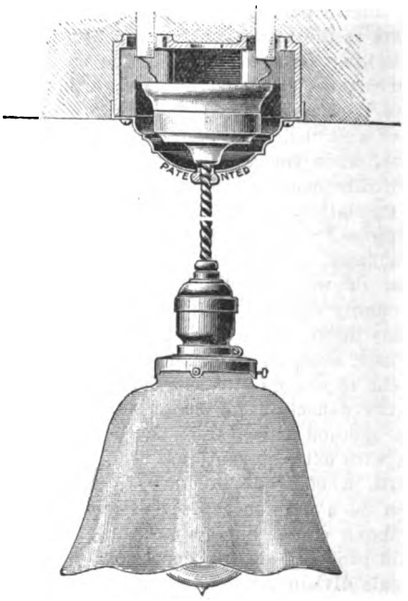



FIG. 11.

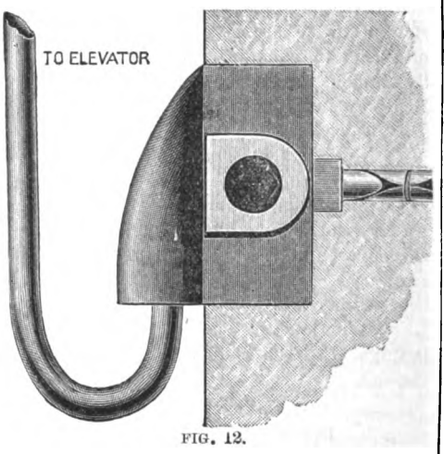



FIG. 12.

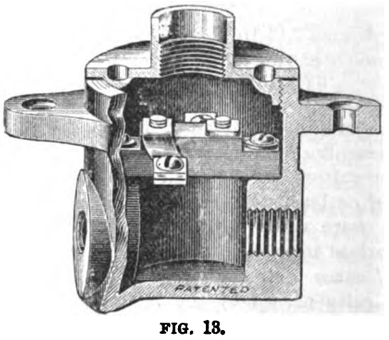



FIG. 13.

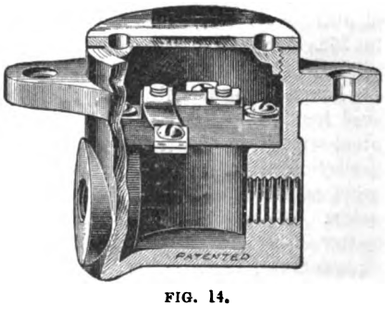



FIG. 14.

**Various Commercial Types of Outlet Boxes.**

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box may be removed by striking the plug with a hammer. Fig. 2 shows a round box and cover with four plugged openings in the side. As will be seen, these openings are not sleeved or tapped. The cover of the box has projecting lips, which are tapped to receive screws for receptacle or wall socket.

Fig. 3 shows a square outlet box with a tapped sleeve opening on each of the four sides. These openings are not plugged, but may be plugged if so ordered. This box is provided with a threaded sleeve for supporting the electric fixture. Fig. 4 is somewhat similar to No. 3, except that it has openings on only two sides, but has two openings in the back to receive tubes coming from the rear. It is also provided with a small section of tubing screwed into the back of the box, through which the gas pipe is intended to pass. Fig. 5 shows a steel outlet box for push-button switches. This box has two tapped openings at each end and one at each side. These holes may be plugged or not, as desired. The slotted openings through which the screws fastening the cover to the box pass are intended to allow for adjustment of the box cover so that the switch cover may be made absolutely straight, even though the box itself be crooked. The switch cover, of course, is fastened by machine screws to the flanges shown at top and bottom of opening. Fig. 6 shows an outlet box with several plugged openings, which are prolonged to the top of the box. This has an advantage which will be mentioned hereafter.

Fig. 7 shows a square cast iron box and cover with two openings in the one side. The tapped holes in the bottom are for securing the flanged stem swing for the fixture support. As will be seen from a close inspection of the cut, the box and cover are split so that the division occurs through the center of the openings. This makes it very much easier to install the conduit and box, as the rear portion of the box may be secured in position, the conduit installed and then the cover fastened in place. The box is also provided with a "stop" (not shown in the cut) which prevents the tube from projecting too far into the box. This stop consists of a short stud, cast in the box, which is prolonged just far enough to stop the edge of the tube without interfering with the tube opening. Fig. 8 shows a similar box designed to receive a wall socket instead of an electric fixture. Fig. 9 shows a round box and cover with openings in the back. This is generally used for a ceiling box, as conduits for outlets in the ceiling usually come in the rear of the box. The tubes in the case of these boxes are prevented from projecting too far into the box by means of the flanged nut, shown in Fig. 16. This nut is fastened by means of a set screw to the fixture support or gas pipe, which passes through the central opening in the box. In some cases the nut is tapped inside and is screwed on the fixture support or gas pipe. Fig. 10 shows a ceiling box with two openings in the back and with a receptacle, lamp and shade complete. The brass canopy screws to the box itself. This box is made in the shape of a truncated cone, so as to give the minimum possible opening in the front, thus reducing the necessary size of the canopy. Fig. 11 shows another form of ceiling box adapted for a drop-cord rosette. Fig. 12 is a box designed for an elevator cable. The tube enters the side of the box, the

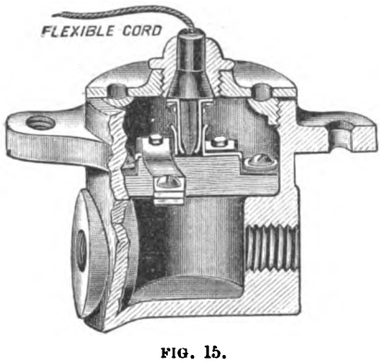



FIG. 15.

connections between the elevator cables and the branch circuit wires being made in the box itself, and the cable passing out through the nose on the cover. Fig. 13 shows a special outlet box designed for the purpose of bringing wires through an outlet in the floor to make connections for a light on a desk or a table. The tube is threaded into the side of the box, as shown, the conduit thread being filled with white lead so as to make a thoroughly watertight joint, the same as is made in gas piping. A connecting block is placed above these two openings, where connection between the concealed wires and the fixture wire running to the table may be made. The fixture wires then pass through a conduit screwed into the cover, which has a threaded stem to receive the same. The lugs on the side of the box



FIG. 16.

serve for securing the box to the rough flooring. The cover fits flush with the finished floor, the floor being bored so as to make a snug fit around the box cover. In case at any time the connections between the floor outlet and the fixture on the table or desk is not needed or wanted, the conduit wires and cover may be removed and replaced by a flat cover with no opening in the top. The box then presents the appearance shown in Fig. 14. This cover fits flush with the finished floor. Fig. 15 shows a means whereby the conduit may be dispensed with and the connection between the floor and table may be made by means of a plug and a cable.

## VALVE REPAIR TOOLS.

As stated on page 427 of the September issue of the American Electrician, the Dexter valve reseating tool has been greatly improved, the improvement in question consisting of an arm attached to the circular frame of the machine, which carries the cutter. This arm carries a sliding bracket and a dead center, as shown in Fig. 1 on the following page. The result of this arrangement is obvious, it being greater steadiness of the disc and less strain on the chuck. The bracket arm for cutting flat discs is also a part of the outfit, as also is the extension for use in cutting discs which are cast solid on the valve stems.

The valve disc is securely fastened to the small chuck, 4, on the machine spindle, and is given a rotary motion by turning the crank, 7, with one hand, while the pointed tool is fed slowly over the disc with the other hand. The pointed tool or cutter is adjusted by the feed screw, 2. To cut a flat disc, the holder, 13, is used, the extension, 3, being used for recutting discs that are cast solid on valve stems. As above noted, this extension becomes necessary in order to obtain the distance required for the operation.

A peculiarly compact form of Block Chuck Valve Reseating Machine is made by R. H. Benton, 23 Vandewater Street, New York, and illustrated herewith by Fig. 2. This may almost be termed a "Vest Pocket Machine," it is so simple and small. A two-jawed "universal" chuck is used for engaging the thread in the bonnet opening, and a sleeve in the chuck carries the cutter spindle and milling discs, as shown in the engraving. The crank is made double. For large valves it is rigged as shown, but for small ones the stem is put into the hole nearest the handle.

This tool will reseat valves from three-eighths to twelve inches in diameter, and is intended to handle not only regulation bevel seated valves, but to take care of flat seated valves, flat checks, taper checks, flange valves and water faucets. The apparatus for handling discs is shown at the left of the engraving. It is a sort of yoke which is attached directly to the universal chuck, and, the disc being placed on the cutter stem in place of the cutter bar, the metal is trimmed off in a hurry, a positive feed being used, as described for seats.

Special forms of regrinding tools are sometimes sent out by valve manufacturers to be used when the seating surfaces have, from accident or neglect, become so badly cut or worn that the usual regrinding has not enough effect thereon. Fig. 3 shows a seat reamer made by the Lunkenheimer Co., Cincinnati, O., for use with its valves. As shown in the left-hand cut, the reamer is put in place of the disc, which is temporarily removed for that purpose. For valves below one inch the solid steel reamer, shown at right of cut, is preferable. Care should be taken in reseating

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valves to take no greater cut than is absolutely required to form a new bearing. It is expected that the discs in connection with this machine are not to be reground, but replaced by new ones as they become damaged or worn out.

The manufacturers claim that these tools are not necessary when their valves are kept tight by frequent and judicious regrinding, when the leakage is only slight, then the usual percentage of regrinding with some abrading material being all that is necessary; but when the valves are subjected to very hard service and become badly worn or cut, then the tools described are valuable, and should be used at once. In using the reamers with T handle, the trimming of the valve is removed and the reamer inserted in its place. On the other sizes the loose valve disc can be removed and the reamer inverted so that the hub guides in the body while the new seat is being cut, thereby making sure that it is always in line with the stem.

These cutters are practically indestructible, as they can be sharpened any number of times without changing their form.

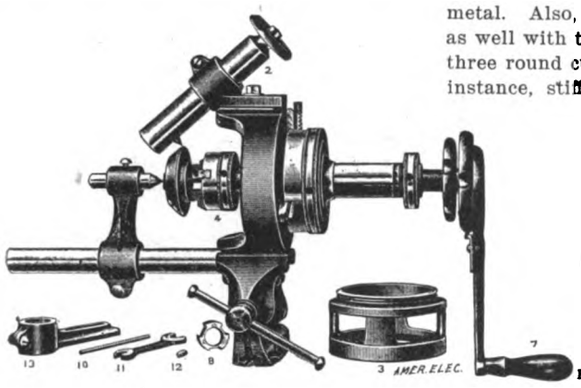



FIG. 1.—IMPROVED DEXTER DISC CUTTER.

The brass discs, or stems, should in all cases be renewed as they wear out. Their cost is very small, and a loose fit there would not be economical practice; hence they should be freely renewed.

A combination machine for reseating all kinds of valves and cocks is shown by Fig. 4. The engraving shows the long taper plug of a cock in the machine, and on solid disc valves it is not necessary to remove the hand wheel. The all-round steel milling cutter is used. Although the engraving gives a good idea of this machine it should be seen in operation in order to obtain a full idea of its capabilities. The action of the three cutters on the face plate cannot well be described to one who has never seen the machine in action. But it can be readily comprehended that round steel cutters will do better work than straight pointed tools which cut at one point only. This is granted by all mechanics, and proved by the milling machine, and also is found to be the case in valve reseating, the pointed tool is apt to cut away too much metal. Also, the work is not supported as well with the pointed tool as when the three round cutters are used. In the first instance, stiffness of the valve or stem must resist the entire side thrust of the cutting tool, but with the round cutters there is no side thrust, the work being equally supported from three sides at once. From three to six taper plugs are all that will be required for the ordinary sizes of valves in an electric light station. The base of the machine may be screwed in a vise during action, or it may preferably be screwed to a table or bench; or it can be used when a disc is placed upon it the truing or centering operation may be quickly done by bringing the cutter against the work, and allowing the whole business to revolve until the disc runs true. Then the set-screw shown on top of the tail-stock may be tightened and the grinding act proceeded with.

This machine takes care of discs, and also by interchanging the gears and cutters, and using a part of the machine, it may be used for ordinary stop valves also. As shown by Fig. 6, the milling cutter is driven by bevel gears, and they are pivoted on a head block, which is centrally adjusted and held in place by a hub with radially adjustable jaws. The cutter is set up to its work by means of a wedge forced down by a screw, shown at the left of the engraving, which bears against the other valve seat.

This machine, as set up for milling gates, as shown by Fig. 6. The gate is held in position by the hub before mentioned, which is secured to the tail stock, while the cutter is turned and fed up to its work by the crank and hand wheel in a manner that has already been described.

A very ingenious, yet comparatively simple, device for reseating all sizes and types of gate valves, wherein the same mechanism is used on both gate and seat, is the subject of illustration in Fig. 7. It is a machine also made by Hall, Son & Company, as described above. The cutting is done by a regular milling cutter

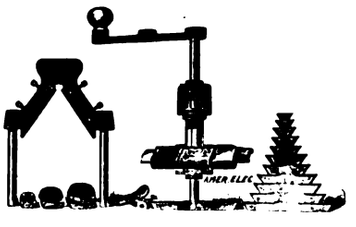



FIG. 2.—BENTON BLOCK CHUCK VALVE RESEATING MACHINE.

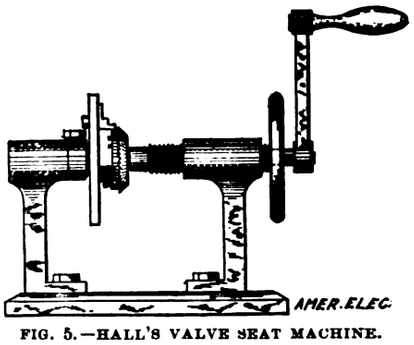
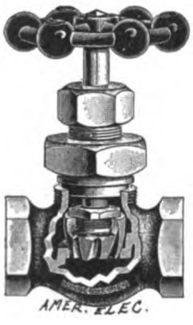



FIG. 5.—HALL'S VALVE SEAT MACHINE.



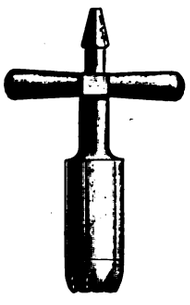



FIG. 3.—LUNKENHEIMER STEEL SEAT REAMER.

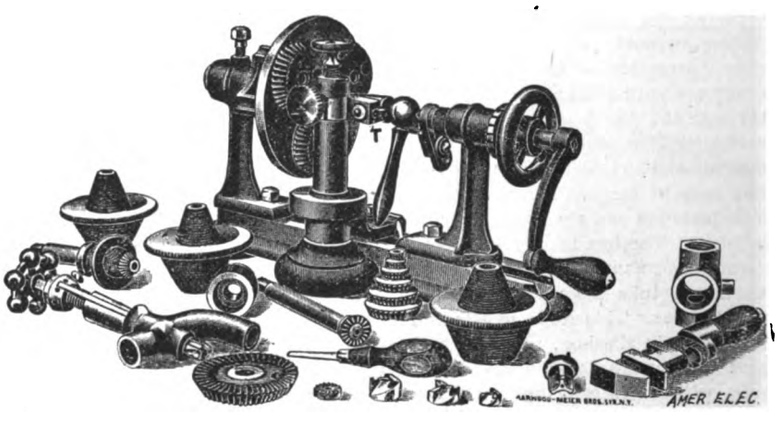



FIG. 4.—HALL COMBINED RESEATING MACHINE.

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which is attached to a rigid frame, and put inside the valve and bolted thereto. Means, not clearly shown in the engraving, are provided whereby the cutter is fed up to the seat. In milling the gate the same mechanism is employed as with the seat, and the gate is placed in a jig which approximates the opening in a gate valve. Then, by means of a suitable clamp, the cutting mechanism is affixed thereto, and the cutter is fed up by means of a screw, shown at D. Some attachments are also shown for attaching the tool to valves of special construction.

One point of the Hall machine is worthy

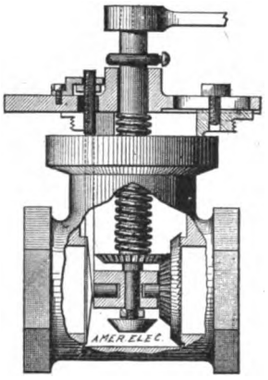



FIG. 6.—ARRANGED FOR GATES.

of especial notice—the machine for reseating plugs and blow-cocks. This device uses the frame and stand shown in the last engraving (Fig. 7), and as presented in Fig. 8, will be seen to resemble that device closely, with the exception of the face-plate which carries the three circular cutters. Fig. 8 shows a plug in the machine at D, and the cock tie at J, with the adjustable reamer in place ready for work. It will be seen that motion is imparted to the reamer by means of the hand-wheel, M. By turning the nut, K, by means of a wrench, the taper of the reamer may be altered to fit the valve to be repaired.

There are three adjustable cutters in this reamer, as shown at I. and also at P, P, in another portion of the engraving. The required taper of the plug is readily obtained by setting over the head and tail stocks and by means of the adjustment already described, the hole may be reamed to fit the plug. Or the hole may be made and the plug fitted thereto, as may be desired. The cocks may be repaired by this machine without removal from their places in the piping.

An improved and very simple form of standard valve reseating machine (by F. S. Dangerfield Co., Auburn, N. Y.) is shown by Fig. 9. A triangular face plate chuck is used for holding a disc while the circular cutter fitted to that particular disc is brought into use. This tool, of which No. 2 is shown in the illustration, is placed on the market in ten sizes and will reseat all globe, angle, gross and

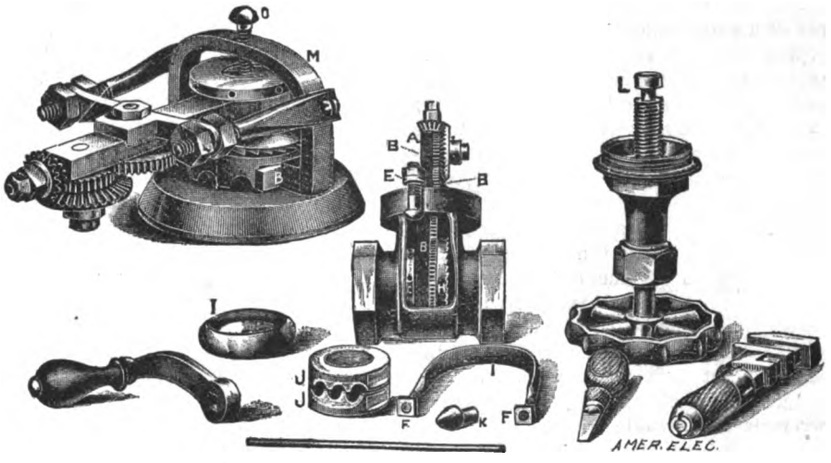



FIG. 7.—MACHINE FOR RESEATING GATE-VALVES

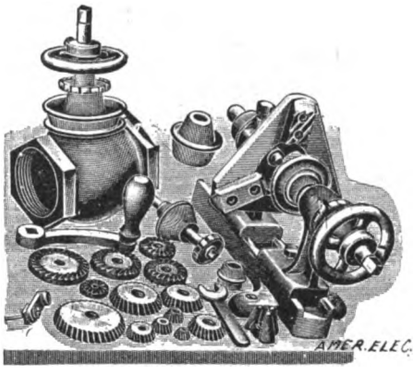



FIG. 9.—IMPROVED STANDARD MACHINE.

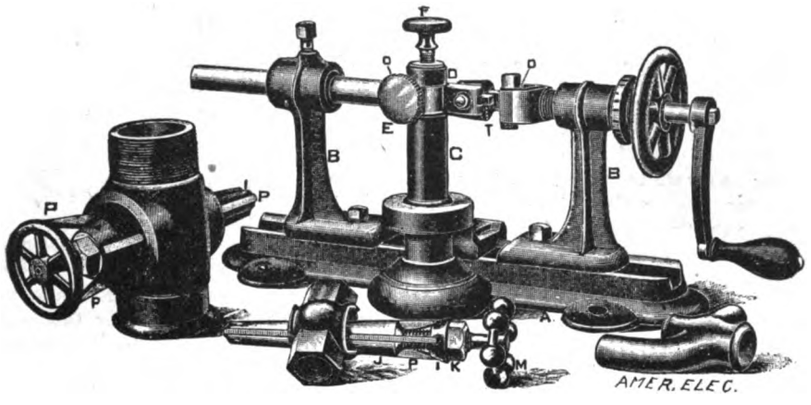



FIG. 8.—FOR RE-SEATING PLUGS AND BLOW-COCKS.

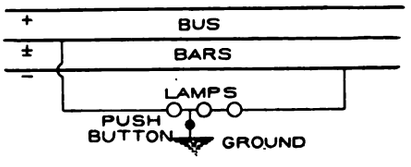
safety valves, drop, swing and ball check valves, Jenkins', Fairbanks', Crane's, Lunkenheimer's, Powell's and all other makes, both flat and taper seats, with screw or flange caps from ¼ to 12 inches inclusive, also faucets, without removing the valves from the pipes, making them absolutely steam tight.

## Letters on Practical Subjects

### A Ground Detector for Three-Wire Systems.

*To the Editor of American Electrician:*

Sir.—Allow me to suggest an arrangement of lamps for a ground detector on a three-wire system which will indicate a ground on any of the three wires without endangering the lamps. The diagram shows three lamps connected in series on one side with a ground through a push




button between the lamp nearest the neutral and the next one, and by tracing it out for different conditions it will be found to indicate differently for a ground on any one of the mains. I find it useful on systems where the neutral is not permanently grounded.

A. P. Kennedy.

Maywood, Ill.

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# Electrical Catechism

*346. Of what material is the field magnet of a motor usually made?*

Wrought iron, cast iron and cast steel are used. Wrought iron has higher permeability than either of the others; this allows the magnetic field to be made more dense, and therefore the whole machine may usually be made smaller for a given power. Cast iron costs less per pound and can be cast into the required shape more cheaply than wrought iron can be forged or punched. Cast steel, containing but a very small percentage of carbon, can now be obtained in any desired form of casting, and is rapidly displacing cast iron because its magnetic properties are almost as good as those of wrought iron, while it costs but little more than cast iron. For very small motors, hardened tool steel is sometimes used, being permanently magnetized so that no field magnetizing coil is necessary.

*347. How is the field of a motor usually magnetized?*

The hardened steel magnets sometimes used with small motors are magnetized by being placed between the poles of a strong magnet or by passing a strong current through a coil placed temporarily around the hardened steel. It is more common to magnetize the field by current through a coil, which is part of the motor, and through which part or all of the motor current passes. If all the current passes through the field coil, it is called a "series field coil." If only a small part of the current passes through the coil, it is called a "shunt field coil." Sometimes motors have both series and shunt field coils.

*348. What are the advantages and disadvantages of using permanent magnets?*

The advantage is that they do not require a continuous expenditure of energy while the motor is running. The disadvantages are that a permanent magnet cannot be made as strong as an electromagnet of the same size, hence the motor has less power; the strength of such a magnet would gradually become less, so that the speed of the motor would increase accordingly.

*349. Under what conditions are series motors used?*

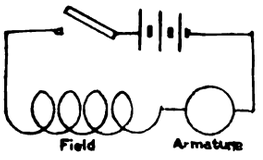
Small motors for use with primary batteries are commonly wound as series machines, likewise motors of any size intended for use on arc light circuits in which the current is of constant strength. Series motors are also used on constant potential circuits, as in railway work and for similar purposes where an attendant is always at hand to regulate or control the speed.

*350. What are the advantages and disadvantages of series motors?*

Series coils are somewhat cheaper to wind than shunt coils, because the wire is larger, costs less per pound and less labor is needed to wind comparatively few turns of large wire than to wind many turns of small wire. This is particularly true of small machines. Series motors are more easily started, especially under heavy loads. They maintain the speed more nearly constant than do shunt motors when on circuits in which the current is maintained at constant strength. When on constant potential circuits, such as used for incandescent lighting or for electric railways, the speed of a series motor will depend upon the load.

*351. How are series motors started on battery circuits?*

Small series motors operated by battery power are started by simply closing a

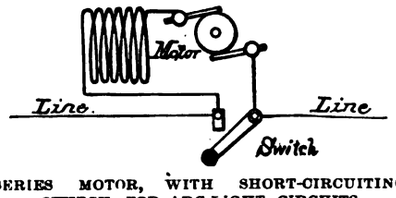



SERIES MOTOR, WITH SIMPLE CIRCUIT OPENING AND CLOSING SWITCH, FOR BATTERY CIRCUITS.

switch to complete the circuit, as indicated in the figure. The resistance of battery and motor is sufficient to prevent too great a rush of current at the start.

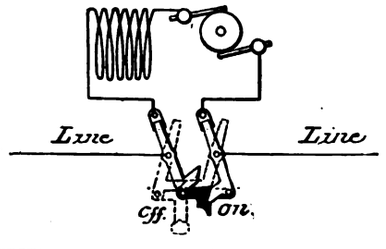
*352. How are series motors started on arc light circuits?*

Motors of arc light or "series" circuits are connected into the circuit in the same way as arc lamps. Some of them are pro-




SERIES MOTOR, WITH SHORT-CIRCUITING SWITCH, FOR ARC-LIGHT CIRCUITS.

vided with a simple single-pole switch that short-circuits the motor when not running, as shown in the figure. To start the motor, this switch is opened, or thrown to the "on" position, thereby sending the current through the motor instead of through the switch. No rheostat or resistance is needed, since the current

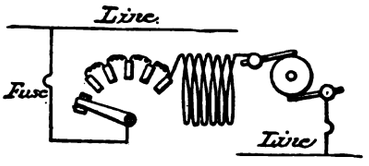



SERIES MOTOR, WITH DOUBLE POLE ISOLATING AND SHORT-CIRCUITING SWITCH, FOR ARC-LIGHT CIRCUITS.

through the motor cannot be greater at the start than when in regular running, this being kept constant by the dynamo. It is better to use a double-pole short-circuiting switch, in order to cut the motor entirely free from the circuit when not running; in fact, this is required by the insurance rules. Such motors require the use of high voltages, do not regulate satisfactorily and have gone almost entirely out of use.

*353. How are series motors started on constant voltage circuits?*

It is necessary to have some auxiliary resistance in series, as shown in the fig-




SERIES MOTOR, WITH SERIES STARTING RESISTANCE FOR CONSTANT POTENTIAL CIRCUITS.

ure, to prevent too great a rush of current at starting. The resistance of a 15 horsepower railway motor is only about 2 ohms. If this were connected to a 500-volt circuit while standing still and without any extra resistance, the current would be something like 250 amperes at the first rush, or more than 150 horsepower. By introducing more resistance into the circuit at first, the rush of current is reduced and the motor starts gradually. As the motor comes up to speed, the extra resistance is gradually cut out.

*354. How are series motors stopped?*

The operations in starting are simply reversed, care being taken to move the switches quickly in order to avoid excessive flashing.

*355. On what kind of circuits are shunt motors used?*

Shunt motors are used almost without exception on constant potential circuits. Some years ago the C & C Company made a motor for arc light circuits, having a combination of series and shunt coils, but this was about the only shunt motor used on such circuits.

*356. What are the advantages of shunt motors?*

They are very closely self-regulating, so that the speed remains nearly constant for any variation of load. They may therefore be left to care for themselves with only occasional inspection of bearings and brushes.

*357. What are the disadvantages of shunt motors?*

The speed cannot be varied through a very wide range without considerable loss. They do not start under a heavy load so easily as do series motors. In case the current should be cut off for any reason, and the motor should not be disconnected from the line before the current comes on again, the motor is more liable to be burnt out than would be the case with a series motor. The shunt motor requires more care in starting than does a series motor.

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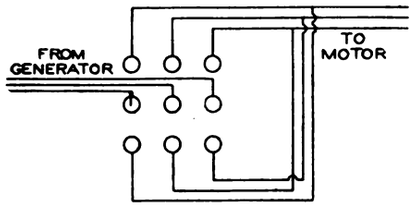
# Queries and Answers

In the Thomson recording wattmeters for direct currents, the terminals to connect to line are marked, one positive and the other negative, and the directions say to connect the + terminal with the + line, etc. Will you please explain why this is necessary? The meter is simply a shunt motor and the direction of rotation is the same, regardless of the direction of the current. J. W. L.

It is true that the Thomson meter is a shunt motor and should run in the same direction and record accurately connected up in either polarity. Although there is no iron or steel in the magnetic circuit of the motor, these materials do enter into the construction of the instrument and may retain a certain amount of residual magnetism, which on very light loads, where the meter is extremely sensitive, may affect the indications. The polarity marks indicate the way in which the meter was connected when calibrated and to obtain the highest accuracy should be followed when set up for service. For all practical purposes, however, it makes no difference which way the meter is connected.

Please give a sketch of how to connect up a double throw switch on a three-phase induction motor, so that the motor can be made to run in opposite directions. J. W.

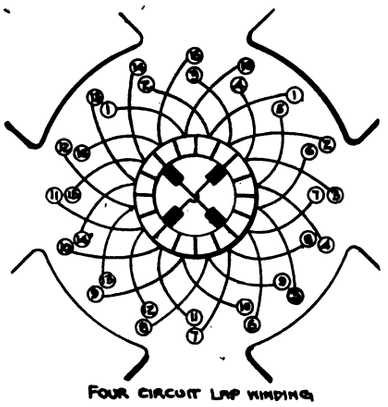
The problem of connecting up a reversing switch to change the direction of rotation of a three-phase motor consists in so winding the circuits that the rotary field of the motor will travel in the reverse direction. If the three legs of the three-phase circuit are brought in the direction in which the phases follow each other, 1—2—3, it is obvious that their connection to the motor terminals must be changed into the order 3—2—1 to reverse the sequence of the phases and hence the direction of the rotary field. Considering the triangle 3 1 2 it is obvious that if these figures are read in clockwise rotation they read 1—2—3—1—2—3, etc. Now, if any two of them are interchanged, for instance, the 2 and the 3, the triangle becomes 2 1 3 and when it is read in the same direction




as before, it reads 1—3—2—1—3—2, etc., which is the same as 3—2—1—3—2—1, etc., i. e., the sequence of the phases has been exactly reversed. If any other two numbers of the first triangle are reversed, the third being left where it is, the result is the same. For instance, interchanging the 3 and the 1 gives the following arrangement 1 3 2 which also reads 3—2—1—3—2—1, etc. This interchanging is accomplished by means of a double pole triple throw switch, according to the sketch given herewith. A double pole switch is all that is necessary, since the connection in the left-hand leg is evidently the same in both the up and down positions of the switch, but it is customary to use a three-pole switch so that when the switch is opened the motor is entirely cut off from the supply circuit.

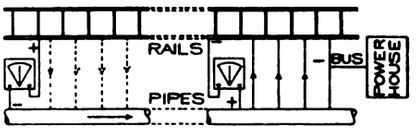
Will you please tell me how to connect the armature coils of the rectifier, the design of which was given in the American Electrician of June, 1899, when used as a direct current generator as per directions given in the Queries and Answers Department of the American Electrician for August. C. S.

The statement in answer to the query in August that the 16 coils could be connected either as a two or four circuit winding was an error. Sixteen coils can only be connected up as a four circuit lap winding. The connection of these coils to give 110 volts at 2400 r. p. m. is shown in the accompanying diagram. The small numbered circles represent the sides of the form wound coils, one side of coil No. 1, for example, occupying the bottom of the slot under coil No. 13, the other side of coil No. 1 occupying the top of another slot 90° away from the first over one side of coil No. 5. The opposite ends of each coil are connected to adjacent segments of the sixteen part commutator, each segment being connected to the end of one coil and the beginning of the next one to it. For instance, one segment connects with the end of coil 1 and the beginning of coil 2 and so on around the commutator. It will be noticed that each commutator segment is about midway between the two sides of the coils to which it is connected. If the terminals of each form wound coil are brought out together at the apex of the coil they will be convenient for connection in this way.




What do you think is the best way of overcoming the action of electrolysis from street railroads on water pipes? E. S. J.

The commonly accepted method in this country of reducing electrolysis is to carefully prevent any metallic contact between the rails and the pipes at points distant from the power house where the current tends to leave the rails and enter the pipes. Near the power house, where the current tends to leave the pipes and return to the rails, the pipes should be carefully connected with




this bus bar by heavy conductors bonded or soldered to them. No damage is done by the current entering the pipes, all metal being dissolved when the current leaves them. The direct low resistance path from the pipes to the negative bus reduces the tendency of the current to pass into the ground and thus back to the rails, while the isolation of the pipes from the rails at distant points reduces the amount of current that enters the pipes and must leave them again. Tests should be made with a low-reading voltmeter connected at different points between pipes and rails. Wherever the meter shows the rails positive to the pipes they should be kept apart from each other. Wherever the pipes are positive to the rails they should be bonded together.

What resistance generators and bells should be used for party lines wired on the multiple or bridging-bell system? Can No. 0 iron wire be used for the line and can 20 instruments be worked on one line of this kind? What size wire should be used for 10 instruments? J. B. O.

Use 1000-ohm ringers and 300-ohm generators, wound with No. 31 B. & S. gage. The generators must be very well made and have powerful magnetic fields. Twenty instruments are too many for good service on any one line. No. 10 B. & S. gage iron will not answer at all, unless the line is short. No. 10 B. & S. gage copper would be better, but unless instruments are exceptionally well made, trouble will be had in ringing. The same construction will answer for only 10 instruments.

Will the increase of temperature of a generator be the same whatever the normal temperature is in the room, i. e., will a machine rise with a given load 72° F. above the room when the room is at 60° F. and when it is at 107° F. respectively? W. D. T.

The rise of temperature of a machine with a given load above the atmospheric temperature will be practically the same, no matter what the latter is. If a machine loaded in a room at 60° F. rises to 132° F., it will, with the same load, in a room at 107° F., rise to about 180° F. At the higher initial temperatures the temperature rise will be a little greater owing to the fact that a given number of cubic feet of air blown through the machine will not represent quite so many lbs. of air since it is at higher temperatures expanded to a greater volume.

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## MOTOR STARTERS WITH INTERLOCKING NO-VOLTAGE AND OVERLOAD RELEASE.

It is now almost universal in high-grade installations to protect direct-current motors with devices which will open the circuit in case of either the failure of the current supplied or the overloading of the motor. The former is most simply accomplished by means of the usual automatic motor starter fitted with a magnet which holds the rheostat arm in the closed circuit position. The overload protection may be obtained by the addition in the lines of an ordinary circuit breaker, but it is naturally preferable to combine this instrument in some way with the starting rheostat and underload device.

There are on the market several such combined protective devices. In one the releasing magnet which holds the rheostat arm in the short circuit position is wound with two coils, one, the usual potential coil in series with the shunt field of the motor, designed to let go when the voltage fails, and the other an overload coil in series with the armature of the motor, this coil neutralizing the magnetic effect set up by the shunt coil when the load rises above normal.

A more commonly used device is an overload coil, the armature of which when attracted short circuits the no-voltage coil and releases the rheostat arm. The objection to such devices compared with a starting box and an independent circuit breaker is the fact that the operator may start the motor under an overload, the automatic devices being inoperative while the operator has his hand upon the rheostat arm.

An instrument in which the overload protection is combined with the no voltage release in such a way as not to be subject to this disadvantage, is made by the Ward Leonard Electric Company, Bronxville, N. Y., and is shown in four sizes in Fig. 1. An examination of this figure and particularly of the upper right-hand rheostat represented therein will show that there are two arms fastened upon the same pivot, one the usual rheostat arm swinging over a number of contact buttons, and held in the short-circuit position by a no-voltage magnet, and the other a longer normally horizontal arm which is held in place by a trigger at its left-hand end, this trigger being within the range of the upward blow of the armature of an overload device similar to that used in circuit breakers. This arm is connected in circuit in series with the rheostat arm and when released by the overload trigger is forced open by the same spring that actuates the rheostat arm, and thereby protects the motor against the flow of excessive currents. The overload or circuit-breaker arm is not fitted with a handle by which it can be closed by hand, but must be restored by moving back the rheostat arm to the open-circuit position, this movement mechanically pushing back the circuit-breaker arm until it latches. If the operator in starting up the motor cuts out the resistance too rapidly the independent circuit breaker will instantly open the circuit, even while his hand is on the rheostat arm. In order to close the circuit breaker again the operator must first insert all of the resistance of the rheostat and then open the circuit by swinging the rheostat arm on to the open buttons, this movement carrying before it the circuit-breaker blade.. When the latter is latched the operator can again establish his circuit and gradually cut out the resistance. If an overload comes upon the circuit at any time with the motor running at full speed the circuit breaker acts and the operator, finding his motor stopped, knows, by an examination of the instrument, exactly what caused the stoppage, whether overload or undervoltage, which cannot be told by other types of instruments.

Another advantage of the same construction is as follows: In case the underload release of the rheostat should fail to operate when the line is opened and the motor should come to rest, leaving the rheostat in the short-circuit position, when the power returns to the circuit the overload arm would instantly open and protect the motor; whereas in the case of single-arm rheostats the motor would receive the entire voltage unprotected. Underload-release magnets are not absolutely reliable in this manner, as the arm must make good contact with the short-circuit jaws, fitting them tightly and requiring a very powerful spring to start it. The spring is also often insufficient to carry the arm, when released, clear over to the open-circuit position, especially if any buttons are burned or rough. In this case when the power returns the rheostat is burned out, as starting rheostats are not made with sufficient carrying capacity to stand the full-load current for more than a moment or two.

In order to overcome both of these difficulties the Ward Leonard Electric Company makes its rheostats of large carrying capacities with what is known as the "hammer-blow" feature. A view of an instrument with this attachment is shown in the lower right-hand corner of Fig. 1. From this it will be seen that the rheostat arm itself does not carry the armature of the no-voltage magnet but does carry a pin engaging another arm carrying this armature and also attached to the spring and handle. This hammer arm itself is freely pivoted and when released by the no-voltage magnet flies back quickly over an arc equal to that spanned by the slot in which the pin on the rheostat arm travels, strikes the latter a heavy blow which overcomes its friction of rest, disengages it from the jaws and carries it quickly to the open-circuit position.

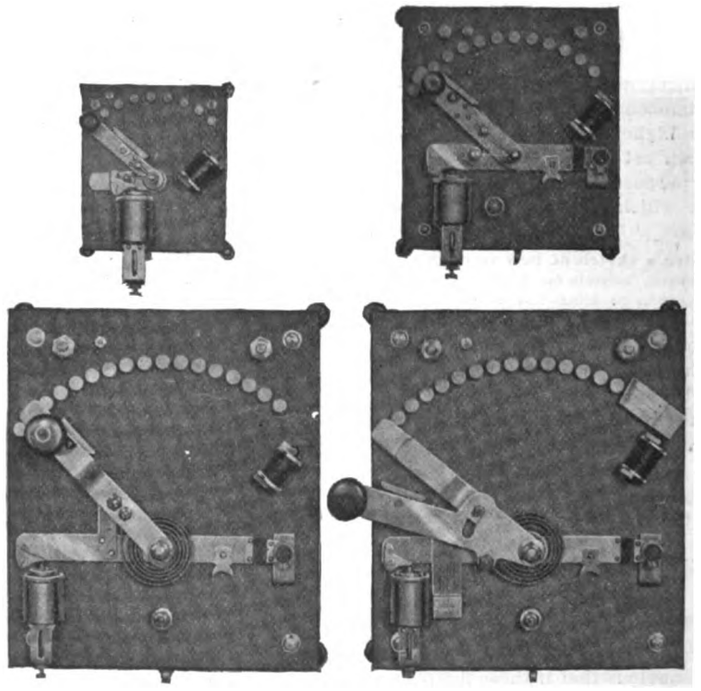


FIG. 1.—FOUR SIZES OF MOTOR STARTERS FITTED WITH INTERLOCKING NO-VOLTAGE AND OVERLOAD CIRCUIT OPENING DEVICES.

The contact of the overload or circuit-breaker arm is made in most sizes by means of a short copper rod, the end of which presses on a copper spring, this rod appearing in end elevation at the right-hand end of the arm. The copper piece on which it bears is flexible, being supported by a strip of phosphor bronze, and the copper rod can be adjusted in a clamp so as to vary the pressure between the contacts. This contact is reinforced by jaws in the sizes for large currents.

Fig. 1 shows four sizes of this rheostat. In the smallest, which is employed up to and including 3-h. p., the current capacity and contact surface are so slight that no hammer blow is needed on the

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no-voltage release and no auxiliary break is needed on the circuit-breaker arm. In the intermediate size which is employed for 5, 7½ and 10-h. p. motors, the auxiliary break is employed on the circuit breaker, but the hammer blow is not needed on the no-voltage release. In the rheostat shown at the lower left-hand corner the current carrying capacity is still light, since it is designed for 500-volt circuits and 15, 20 and 25-h. p. motors. The auxiliary break is used on the cir-

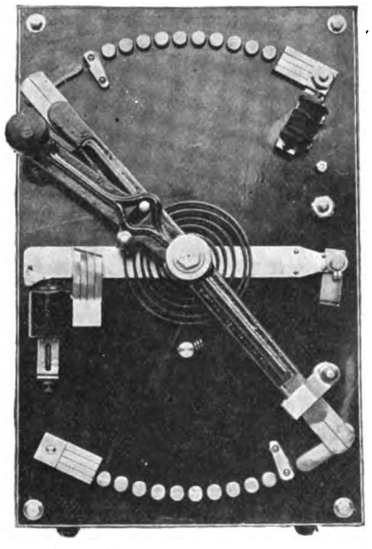


FIG. 2.—A 50-H. P. STARTER WITH ALL FEATURES.

cuit breaker, as the power of the circuit broken is considerable, but the hammer blow is not needed on the arm as low-resistance contact jaws are not used. The rheostat shown in the lower right-hand corner is that used for the same power motors on low-tension circuits, the final contact of the rheostat lever having jaws of the knife-blade type, insuring low resistance and no heating. The hammer blow is here necessary in order to start the blade.

The largest size of this style is 50-h. p., which is shown in Fig. 2. In this instrument the current, after passing through the solenoid and the knife-blade contact of the circuit breaker, divides from the center stud into two paths in multiple, i. e., the upper half and the lower half of the rheostat are two distinct resistances connected in multiple with each other. This doubles the carrying capacity of the instrument without increasing the size of the parts and gives balanced resistance to turning about the hub and smoother working. This instrument clearly shows the construction of the bumpers, which are not of rubber, as in other makes, but are coiled springs, giving a longer life. The rheostat arm is, in this instance, provided with a pair of friction clips at the lower right-hand corner for catching the arm and stopping it smoothly, there being also a coiled spring between the clips. The same view shows a modified construction of the first contact, which is elongated to give a larger surface for the heavy current required to start the motor against the friction of rest as well as to provide increased arcing surface on opening the circuit, since the greater the amount of metal the less will be the destructive action of a given arc. Another improvement of the same detail is the cutting away of the arcing edge in line with the contact buttons so that any burning of the rheostat arm will not roughen it where it travels over the various steps.

Another and still newer type of instrument, also made by the Ward Leonard Electric Company, is illustrated in Fig. 3, this being a motor controller as distinguished from a motor starter, and intended to carry the full load current on any step. The rheostat arm is not spring actuated and may be set on any button, another arm carrying the armature of the no-voltage release and the spring, this arm acting to give the rheostat arm a hammer blow and drive it to the open-circuit position from any button on which it may be placed. This instrument is made in two types, one designed to reduce to half speed a motor whose load requires the same torque at any and all speeds and wound, therefore, with a resistance of uniform carrying capacity throughout. The other is intended to reduce to half speed a motor driving a load of which the torque falls off as the speed goes down, such as a ventilating fan, the resistance of this rheostat being given a 2 to 1 taper in ampere capacity from the short-circuit to the open-circuit end.

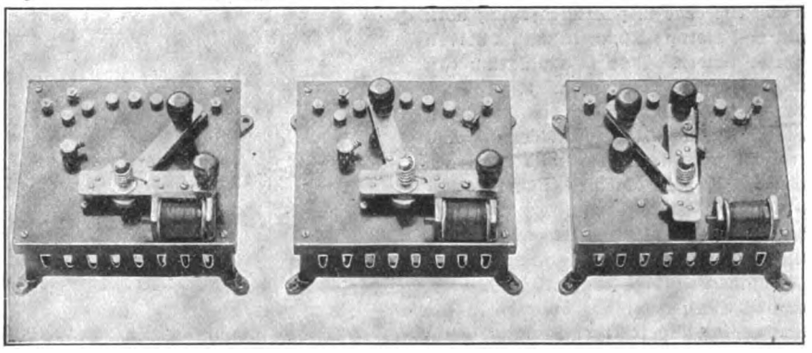


FIG. 3.—MOTOR CONTROLLERS WITH "HAMMER BLOW" NO-VOLTAGE RELEASE.

In the starters made by this company the resistance material is in the form of a high resistance strip, somewhat similar to German silver, which is about .002 of an inch thick and whose width is proportional to the ampere capacity desired, the object of this being to secure the maximum possible surface for a given cross section. This ribbon is reflexed back and forth edgewise and formed into steps, and proper terminals are attached at the junctions of different steps. This ribbon so formed is then attached to the back of the slate, the ribbon being held in position by pins, thin sheets of asbestos being employed to insure that no vibration can possibly bring the adjacent rows of ribbon into contact with each other.

The slate, with the switch part on the front and the ribbon on the back, is then fastened to the front of a casting, which is in the form of a shallow box with the front removed; i. e., the slate forms the front side of the box. There are two holes, into which screw plugs go, at the top edge of the box, and through these holes the box is then entirely filled with the best grade of white sand. Sand has exceedingly valuable properties for use in connection with starters; its first cost is comparatively low, its specific capacity and conductivity for heat is quite high, and its mobility insures continual contact with the ribbon at a very great number of points. Its use for this purpose is similar to the familiar sand bath used in laboratories in connection with flasks and beakers, in which case the sand serves the purpose of storing a large amount of heat and of conducting it rapidly to the lower surface of the beakers at a very large number of points. These same properties apply in the case of a starting rheostat in which the ribbon is suddenly heated by a large current and it becomes important to rapidly conduct away from the resistance a large amount of heat energy and store it up in a comparatively small volume, from which it will slowly radiate during the interval of rest, before the motor is started again.

Sand has also the good feature that it can be very quickly applied by merely pouring it into the box through a funnel, and similarly it can be very readily removed in case it becomes desirable to inspect the inside of the box, and after inspection the sand can be readily replaced by any unskilled person. The joint between the chambered casting and the slate is made by means of putty, which prevents the sand from leaking out.

The dimensions of the starting rheostat made after this style are extremely small compared with those of any other type. The 50-h. p. starter shown in Fig. 2 has a slate which is only 16 inches by 25 inches, and the depth of the rheostat is only about 3 or 4 inches. A starting rheostat for 50-h. p. made by any of the former methods would be probably ten times the size of this one in volume.

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## THE CHAPMAN VOLTAGE REGULATOR.

In spite of the perfection of the speed regulation of modern prime movers, as well as the voltage regulation of modern dynamos, the extreme requirements of high efficiency incandescent lamps necessitate a close watch of the voltage on the part of station attendants and frequent manipulation of the rheostat. This is particularly the case in plants carrying both a light and motor load, or in plants driven by water power. This manipulation can be done just as satisfactorily, or even more so, by automatic means, reducing considerably the attention necessary and allowing the station attendants to give a much greater part of their time to other duties.

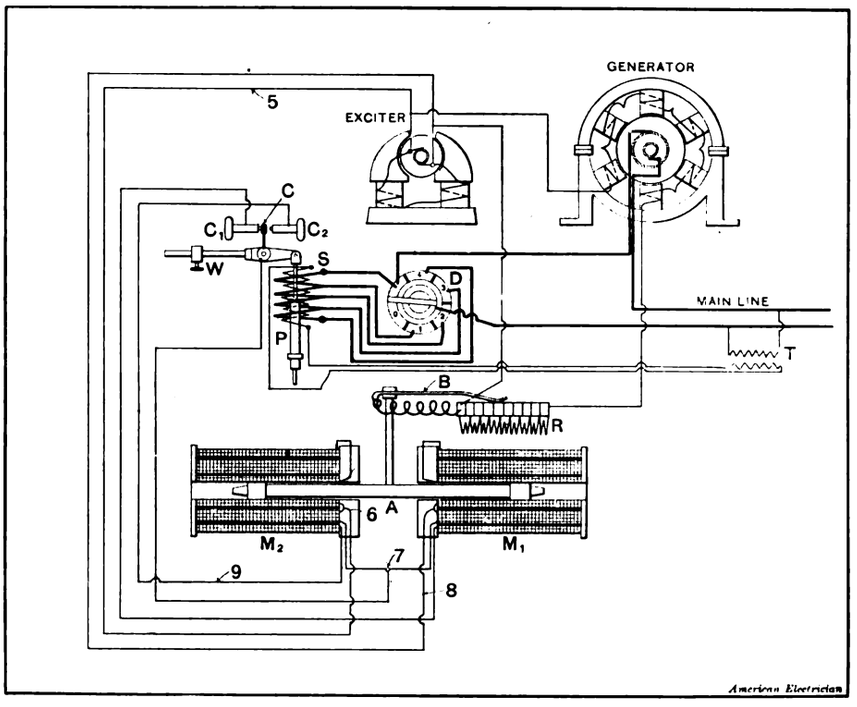



FIG. 1.—THE CIRCUITS OF THE CHAPMAN REGULATOR.

The most generally used means of manipulating the rheostat automatically is the Chapman voltage regulator. A view of one of these machines appears in the accompanying illustration, Fig. 2, a complete diagram of the parts and circuits of an instrument regulating an alternator being shown in Fig. 1.

The instrument in principle embodies a solenoid connected across the mains and thereby excited in proportion to the voltage of the machine, this solenoid operating a delicately poised movable contact which plays between two stops. The solenoid and its plunger have no other work to do than to operate the light contacts, serving as a relay to control a more powerful mechanism which does the work of moving the rheostat arm. The instrument is thus sensitive to a very slight differences of voltage.

In Fig. 1 the generator to be controlled is shown in the upper right hand corner of the diagram with the exciter slightly to the left of it. The main generator circuit passes out to the right and across it is connected a transformer T. The secondary of this transformer supplies the inside or high wound coil of the solenoid S. The magnetism set up by this solenoid tends to lift the plunger, P, against the force of gravity and thereby to operate the contact, C, between the two back contacts $C_1$ and $C_2$. These three contacts are connected into the circuits of a pair of powerful magnets, $M_1$ and $M_2$, which in turn act upon the opposite ends of a soft iron armature, A. This armature is attached at its middle point to a post carrying the rheostat slider or brush, B, operating over the segments of the field rheostat, R, and cutting out more or less of its resistance according to the position which the brush occupies. The voltage at which the relay shall lift up its plunger is adjusted by means of the sliding counterweight, W.

The coils of the main magnet are supplied under the control of the contacts from the exciter and are ingeniously wound so that the making and breaking of the circuits gives least inductive action and negligible sparking at the contacts. This is accomplished by winding the magnets differentially and connecting the contacts so as to neutralize one magnetic field when a contact is made. Each magnet, $M_1$ and $M_2$, is wound with two coils, one formed, as shown, of the outer and inner layers, and the other of the intermediate layers. The different coils are connected up as follows: From the upper brush of the exciter the wire, 5, leads to the terminal, 6, of the magnet, $M_2$, where it forks, one circuit passing through the middle coil to the common junction, 7, and thence through the middle coil of magnet $M_1$ to the wire, 8, and back to the lower brush of the exciter. This circuit is constantly excited.

From point 6 another circuit leads through the inner and outer layers of $M_2$ in series with each other through the wire, 9, to the contact, $C_2$, which, when contact, C, is in the right-hand position, gives another path from the point, 6, to the point, 7. The coils in this path are wound in the opposite direction from that in the other path and the current divided through the two neutralizes the magnetism of $M_2$. At the same time the increased current due to the reduced resistance of the two coils in parallel with each other increases the magnetism of $M_1$ and draws the armature, A, to the right. A similar connection of the coils

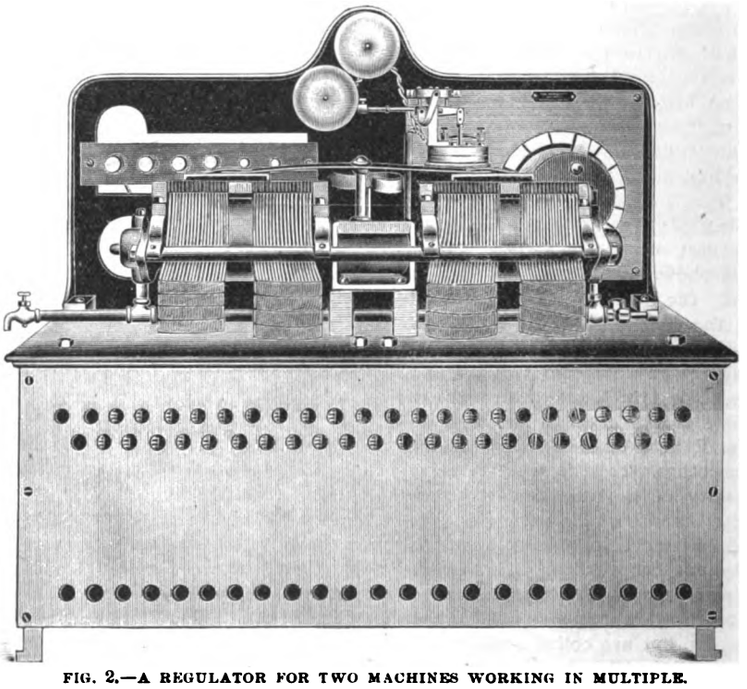


FIG. 2.—A REGULATOR FOR TWO MACHINES WORKING IN MULTIPLE.

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of $M_1$ and the contact, $C_1$, gives a reverse movement without retractal springs or weights.

The movement is rendered sluggish by making the spools on which the magnets, $M_1$ and M , are wound, into oil dash pots, the ends of the armature, A, serving as pistons. The outer ends of the dash pot are connected through a small pipe and a petcock, the adjustment of which allows the speed of the armature in either direction to be controlled with precision.

A description of the operation of the parts may make their purpose more clear. When the voltage, for any reason, rises above that for which the instrument is set, the transformer, T, magnetizes the inner solenoid, S, and draws up the plunger, P, making a contact between C and $C_1$ as shown. This throws the two windings (one right-handed and one left-handed) of magnet $M_1$ in parallel with each other, neutralizing the magnetism which draws the plunger to the right, and allowing M to pull it to the left. This moves B to the left, cutting in more resistance in the field rheostat, R, in series with the separately excited field of the main generator.

The solenoid, S, affecting the delicately poised relay, is in this instrument compound wound, the outer coil being connected in series with the main line. The compounding may be adjusted at any time while the machine is running by means of the rotary dial switch, D, the segments of the switch, 01234, being tapped to different turns of the series winding of S. By rotating the switch arm the series current may be sent through any required number of turns, changing the amount by which the machine will over-compound. Alternators of any size may be compounded in this manner without commutators for rectifying the current in the series fields.

The instrument shown in Fig. 2 has two independent rheostats for running two machines in parallel, the sliders or brushes of the two rheostats being mechanically connected to one main armature. Each of these rheostats has two separate commutators and brushes, so that a considerable change of resistance is effected with a limited movement and with segments of reasonable width.

The apparatus is made by the Belknap Motor Company, Portland, Me., whose representative for the Middle Atlantic and Southern States is Mr. A. W. Koenig, with offices in New York City.

## ANOTHER SERIES ALTERNATING ARC SYSTEM.

In the endeavor to adapt one kind of current to all the services of central stations so that but one type of generator need be used, the alternating-current motor and the alternating-current constant-potential arc lamp have been brought to a satisfactory stage of perfection. More recently the problem of running series arc-light circuits from constant-potential alternating-current mains has been attacked, and the General Electric Company has developed a system of constant-current transformers which was described in the issue of the American Electrician of last July. These transformers, as the reader may remember, take the power at constant potential from the bus bars or lines into their primaries and deliver constant current from their secondaries regardless of the resistance of the secondary circuit within the capacity of the transformer, the voltage delivered to the secondary circuit being adjusted for its varying resistance by automatically varying the position of the coils on the transformer core.

Another and simpler means of accomplishing the same purpose has been developed by the Manhattan General Construction Company of Newark, N. J. In this system the series circuit of lamps is connected across the constant potential mains without any special transformer, but in series with a regulating reactance coil. This coil automatically increases its choking effect when the lamps are cut out and the resistance of the line is thereby lowered, and vice-versa, and in this manner maintains constant current in spite of the constant-potential supply. The regulating reactance coil consists of a single coil swung at one end of a counterweighted arm, so that by moving vertically it will enclose more or less of one leg of an upright U-shaped laminated core of an open magnetic circuit. Normally when no current is flowing the coil is held by the counterweight outside of and above the core. When the circuit is completed through the lamps the magnetic attraction of the coil for the core causes it to be drawn down, and as the current increases the coil is drawn to a lower position. The self induction or choking effect of the coil increases as it lowers around the core, thereby regulating automatically and in a very simple way the strength of the current to a value determined by the counterweight.

This regulator may be furnished with self induction sufficient to provide for the extinguishment of all the lamps in the circuit, or if the circuit is a street lighting one and but a few lamps are likely to be out at any one time, the regulator may be smaller and sufficient only to give a choking effect the equivalent of 10, 15, 25 or any other percentage of the total voltage. In this case the cost of the regulator is greatly reduced, as not only is it smaller, but the strain upon its insulation and the necessary dielectric strength therefore are correspondingly reduced. For this reason the regulating reactance coil is cheaper to build than the automatic constant current transformer, since the latter—even if provided for regulation with only a small percentage of the lamps extinguished—must have a core and coils capable of transforming the total power and insulated for the whole of the high secondary voltage.

## THE HISTORY AND PRESENT STATUS OF THE ARNOLD ELECTRIC POWER STATION COMPANY.

When some five years ago the advantages of direct-coupled dynamos and engines, as compared with belted arrangements, were fully appreciated, one factor that hindered their more rapid adoption was the diminished flexibility incurred by the new system.

In the transformation of energy from the coal pile to the electrical circuits it has become approved practice to connect the steam pipes of all the boilers and engines together to one main or header so that any engine can get steam from any boiler, and to connect all the generator leads and feeders to one set of bus bars so that any load can get current from any dyuamo. In plants built in the past a similar trunk system for the mutual interchange of mechanical power was provided by the countershaft, to which any engine could deliver power and from which any generator could obtain it. Ordinary direct-coupled units failed to provide this cross connection of the power-transforming apparatus at the mechanical stage.

Mr. Bion J. Arnold set himself to the task of devising a means of overcoming this deficiency in direct-coupled plants and developed what is known as the "Arnold System," in which a number of engines and dynamos are set up in line with each other with appropriate interconnecting shafts and clutches, by means of which the different machines can be run together or separately, just as they can when connected by belts to a countershaft. A clear comprehension of the general principles of this system can be obtained by a study of the description of a plant of this kind appearing on another page of this paper under the title, "The Isolated Plant of a Wholesale Grocer's Establishment."

The Arnold Electric Power Station Company was organized in 1896 to make and sell the parts peculiar to the "Arnold System" of power station construction, and acting in this capacity it has supplied a number of plants with magnetic clutches, shafts, quills, box stands and couplings. Through natural development this company has gradually broadened the scope of its work until it is now in position to make propositions for furnishing and erecting in place entire electrical installations.

The entire power plant and building of the Imperial Electric Light, Heat & Power Company, at St. Louis, Mo., was constructed by the Arnold Company. This plant is a large central station using 500-volt generators working in parallel with a storage battery auxiliary. By dividing this battery into two parts a distribution system was devised which allowed the use of 220-volt incandescent lamps, arc lamps, and power motors off the same mains, a decided departure from central station practice in this country. This system has been adopted for another large

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central station since the erection of the Imperial plant.

The Arnold Company was also given the contract for the complete light, heat and power plant erected in connection with the new railroad shops of the Chicago Great Western Railroad at Oelwein, Iowa. This contract comprised not only the heating and lighting of the shop buildings, covering many acres, from a central plant, but also the application of a large number of motors for various uses. This has been the first plant to adopt the Arnold magnetic clutch for line shaft work, though these clutches have been used for some time in connection with the three-way couplings which are a part of the Arnold system of power station construction.

The Arnold Company has extended its field of operations into the complete equipment of the power generating and distributing systems of electric railways and notably of long distance roads. The most elaborate work of this kind undertaken by the company is that for the Chicago & Milwaukee Railway, a line 27 miles long, recently completed along the shore of Lake Michigan, north of Evanston.

Mr. Arnold, while acting as consulting engineer of this road, realized four years ago, and probably as early as any one else, the advantages for such lines of polyphase distribution and the rotary converter, especially when combined with storage batteries at the sub-stations to render uniform the load on the generating, distributing and converting system, a combination which has since been adopted for several large systems both in this country and abroad. In spite of its novelty and the engineering problems to be solved in connection with it, and in the face of considerable opposition, Mr. Arnold advocated this plan strongly for the road above mentioned and finally, in order to justify his position, the Arnold Company took the rather unique contract for the completion of the power station, sub-stations and lines laid out in this way and guaranteed the entire system to work with a certain specified efficiency.

This contract included the engine, direct-current and alternating-current generators, switchboards, transformers, rotary converters, economizer, pumps, mechanical draft, condensers, piping, cooling table and reservoir, power-house building, battery room, car barn, offices, two sub-stations, overhead equipment and transmission line erected complete, ready for operation. The contract for this equipment would have been notable in itself, but the economy clause gives to it an added interest.

The policy adopted by the Arnold Electric Power Station Company of working out its own solution of an engineering problem, of submitting plans and specifications, with its proposition, together with an economy guarantee covering the entire installation, takes this company at once out of the ordinary class of contracting companies and places it in a position peculiar to itself. Another unique feature of the Arnold Company's methods is that it is in no way connected with any manufacturing company, which leaves it free to purchase machinery and apparatus of any make upon the open market.

The advent into general electrical contracting work of a company prepared with an organization capable of handling the largest contracts and willing to guarantee the operation and economy of a completed plant or installation is a development which promises to bring about new methods in building extensive electric properties.

## THE WESTINGHOUSE GAS ENGINE.

So much has been written of late concerning the adaptability of gas engines in general, and this one in particular, to the driving of electrical generators, that nothing need be said here on this subject or the general principles of gas engine operation, the article below being largely a description of the details of construction of the Westinghouse engine.

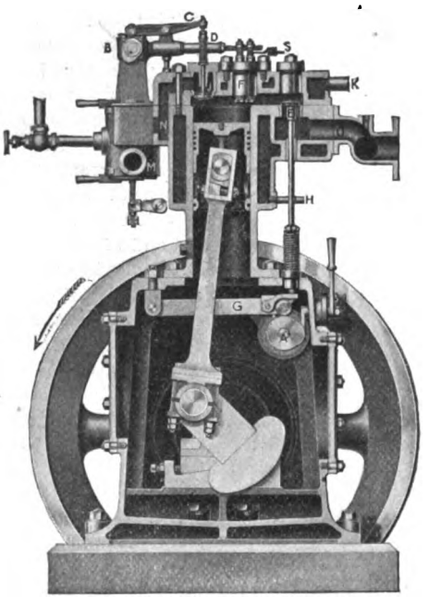



FIG. 1—SECTION THROUGH ENGINE.

Like practically all other types of commercial gas engines, the Westinghouse is single acting and operated upon the Beau de Rochas, or, as it is more commonly known, the Otto cycle.

Unlike other gas engines, however, the Westinghouse does not govern its speed on reduced loads by skipping impulses, the reduction of power in this engine being obtained by throttling the incoming air and gas and thereby reducing their quantity during each cycle without materially changing their relative proportion. The governor can thus assume any intermediate position and on a steady load remain in this position instead of being compelled to travel constantly back and forth over its entire range in order to hit or miss a stroke. This constant travelling from limit to limit is necessary on hit-or-miss governors and necessitates a constantly recurring variation of the speed from the upper to the lower governing limit and vice versa, no matter how heavy the fly wheel may be made.

The engine is vertical, with either two or three cylinders, in all sizes as yet constructed, thus getting either one impulse per revolution, or one during every two-thirds of a revolution. The cylinders are mounted on top of an enclosed crank case resembling in appearance and functions that of a Westinghouse steam engine. A good idea of the arrangement of the parts can be obtained by reference to the vertical cross section, Fig. 1.

Their operation is as follows: The entering gas and air come in through openings, one of which is shown at M, to and through the mixing valve, the purpose of which will be described below, and pass through the port, N, to the upper side of the poppet valve, J. This is depressed by a cam shown on the cam shaft, B, acting on a lever, C, once during each two revolutions of the engine in order to admit fresh gases above the piston. The latter is of the trunk type, enclosing its own crosshead pin, which has the usual wedge arrangement for adjusting the phosphor-bronze boxes. An interesting detail of this part of the engine is the hole through the piston wall opposite the screw of this wedge and the hole near the lower end of the cylinder, with a plug which can be removed, and through which an ordinary socket wrench can be inserted when the piston is in the proper or lowermost position, to adjust the crosshead pin boxes.

The exhaust valve is also of the poppet type and is shown at E. It is lifted against a spring by means of the lever, G, a roller on which bears on a cam on the shaft, A. This also operates once during every two operations of the engine in proper time to release the burned gases. The cycle of operation is as follows:

The piston being in its uppermost position and the cylinder cleared of the last charge, the valve, J, is opened and the piston descends, drawing into the cylinder an explosive mixture of gas and air of a quantity determined by the governor. The valve, J, then closes and the piston returns upward, compressing the charge into the clearance space in the head of the cylinder. The mixture is then ignited and the piston descends again, pushed down by the high pressure caused by the burned gases. The valve, E, is then opened, and the piston rises, driving out the exhaust gases, and leaving the cylinder in condition for a repetition of the same events.

The ignitor is electrical in character and is shown at F, and in greater detail in Fig. 2. It consists of a removable bonnet containing two independent sets of contacts, only one of which is in use at one time. These are brought together by a cam on the upper shaft B, operating through the guide, D, and are suddenly

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released and forced apart by springs at the proper time for the explosion, that is, when the piston is at the head of the cylinder with a compressed charge of air and gas in the clearance space. The failure of either pair of contacts to work can be instantly remedied by transferring the wire from one to the other of the binding posts and thus bringing into service the other pair. The location of all parts of the ignitor in the removable bonnet makes their removal and renewal peculiarly easy. A similar construction is adopted for the admission valve and even the exhaust valve is placed under the bonnet shown at S, through which it can be readily lifted out for cleaning or regrinding.

The engine is water-jacketed to prevent overheating, the cooling water entering at H, passing upward around the cylinder and through the cylinder head and out at K.

The arrangement of the governor and its parts is shown more clearly in Fig. 3. The speed sensitive device is of the ordinary centrifugal fly ball type, moving upwardly or downwardly a mixing valve above it. The nuts holding two vertical coil springs to either side of the valve stem allow the speed to be changed or adjusted even while the engine is in operation. The mixing valve carries ports for both gas and air. The valve seats of either or both of these may be manipulated by hand at any time even when the engine is running so as to regulate the relative opening of the two and thereby the ratio of gas to air in the entering mixture. There will be seen just above and below the valve chamber two handles with index fingers operating over scales. One of these affects the air port and the other the gas port through the valve. By varying the relative openings at any time while the load is constant and watching the position of the governor, the mixture giving lowest consumption of fuel can be found by actual trial instead of by guessing as in other engines.

The automatic starting of engines too large to be started off by hand is ingeniously provided for by means of an air compressor and a storage tank and an arrangement to use one of the cylinders as a compressed air motor for a few turns in starting. The tank when shipped is charged to 160 lbs. pressure and is recharged after starting by a belt, which is then thrown off, or it can be recharged by hand. To start the engine the admission valve of one cylinder is rendered inoperative and the exhaust valve of the same cylinder is thrown by means of a handle appearing at the right-hand side of Fig. 1 on to a separate cam which causes the valve to open during every up stroke instead of every other up stroke of the piston.

The compressed air supply is then turned into this cylinder through a small auxiliary starting valve which turns the air on during every down stroke of this one cylinder, and the engine is turned over by hand gear until the air is admitted and forces the piston down. The other cylinder or cylinders then take hold, operated by gas, as usual, and bring the engine up to speed, when the one used as an air motor may be restored to its proper function. Three or four revolutions with the air pressure are generally sufficient. The largest engine so far constructed, viz., one of 650-h. p., is regularly started by one attendant in this manner.

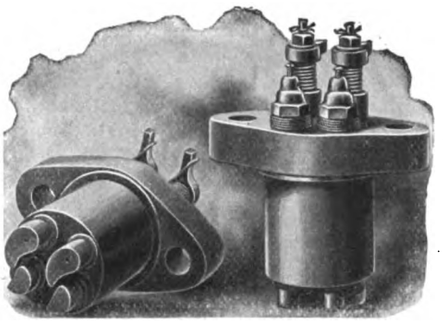


FIG. 2.—TWO VIEWS OF THE IGNITOR.

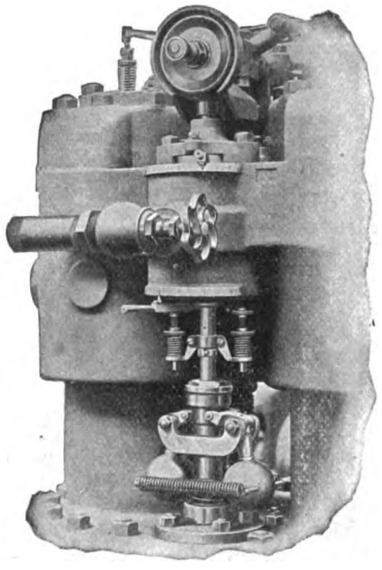


FIG. 3.—THE GOVERNOR OF A TWO-CYLINDER ENGINE.

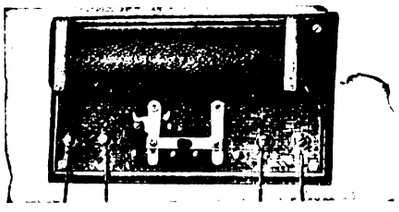


FIG. 4.—THE BATTERY SPARK COIL.

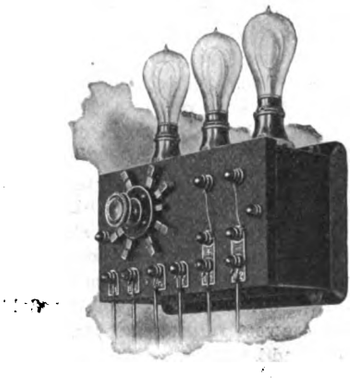


FIG. 5.—THE DYNAMO SPARKING OUTFIT.

The current for the ignitors may be furnished as usual by a battery through a sparking coil, the battery being connected up with a reversing switch so that the direction of the current through the igniting apparatus may be reversed at will. The coil and switch are shown in Fig. 4. This reversal is used to prevent the passage of the spark from eating away one terminal and depositing its material on the other, the reversal interchanging the parts and returning the material to the terminal first eaten away. The switch is fitted with a locking device such that whenever the battery is cut out, as it should be when the engine is shut down, it can only be cut in again in the reverse direction.

When a direct current lighting or power circuit is convenient, it may be tapped for supplying the ignitors, the switching device for this arrangement being shown in Fig. 5. This is fitted with lamps to serve as a resistance in series with the contact and with the sparking coil, which is, in this case, located within the box. The switch is so arranged that either the battery or the dynamo current may be cut in at will and so that each time a change is made the direction of the igniting current is reversed from that on the previous run.

These engines can be worked with gasolene by means of a special "gasifier" made also by the Westinghouse Machine Company. This consists simply of a cylinder into which the gasolene is sprayed and through which air is drawn to the gas inlet of the engine. In this cylinder the fine gasolene spray vaporizes and is carried along by the stream of air, making a gas of suitable richness. The change from the liquid to the gaseous state absorbs considerable heat, which is supplied by means of a water jacket around the gasifying cylinder, which water jacket is supplied with warm water from the water cooling jacket of the engine cylinder.

The gas consumption of this engine is given by the makers as follows:

Natural gas, 10 to 12 cu. ft. per brake horse power hour.

Ordinary city gas, 15 to 17 cu. ft. per brake horse power hour.

Commercial 74° gasolene 1/9 to 1/8 gal. per brake horse power hour.

The probable consumption of fuel for producer gas, as estimated from experiments carried on at the works in Pittsburgh, will be about 1¼ lbs. of anthracite coal per brake horse power hour in small and about 1 lb. in large engines.

As noted above, the largest engine built as yet is of 650-h. p., but the company states that "Neither in its construction or working have we encountered anything which would lead us to think that the limit of size has been anywhere nearly reached."

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## THE NEW LINES OF MANUFACTURE OF THE SIEMENS & HALSKE ELECTRIC COMPANY.

The fact that the Electric Vehicle Company has bought the stock of the Siemens & Halske Electric Company of America and will at the works of the latter company manufacture electrical machinery for its vehicles—for which other allied companies, viz., the Electric Storage Battery Company and the Columbia and Electric Vehicle Company, will manufacture other parts—has led to a general belief that the Siemens & Halske Company would cease operations as a manufacturer of dynamos and other electrical machinery for the general trade.

So far from this being the case, the Siemens & Halske Company, to which new life has been brought by its present powerful financial connections, is branching out into a line of electrical manufacture almost as general as that of the two largest concerns in this line in this country and on a scale excelled only by these two.

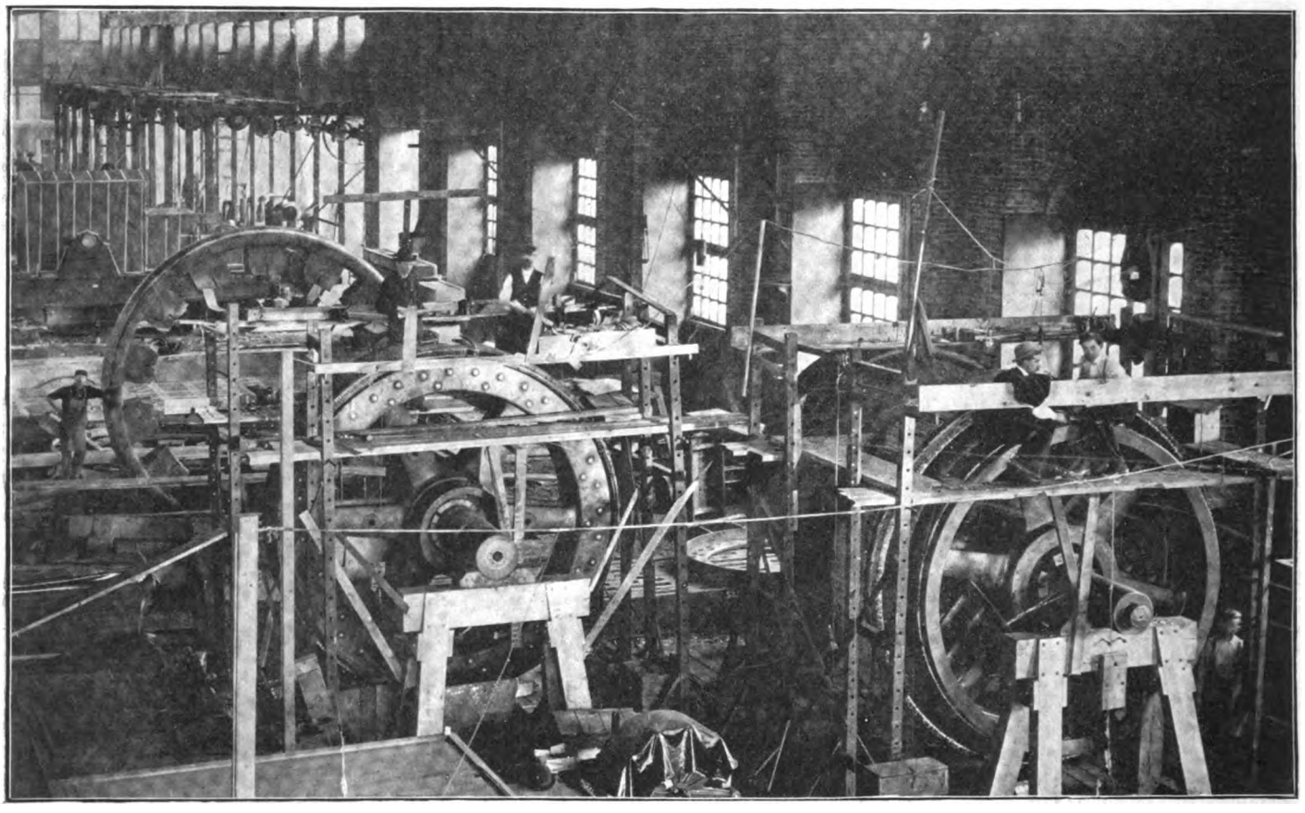
The agreement with the German parent company of the same name, granting the American company the rights to all its patents in this country, still holds, and the American company has engaged a large staff of engineers and draughtsmen and is vigorously pushing work on a great number of new designs. The works in the West Side of Chicago, formerly the Grant Locomotive Works, have assumed a new air of activity, the force having been increased within thirty days by some 250 men, including a night shift. Another large building, not previously occupied by the company, will probably be taken and filled with the automobile work. In this line the company is already at work on 2,000 motors for the recently heralded order for 4200 automobiles. The older portions of the works have been fitted out with much new apparatus, including a heavy testing floor, a new japanning room, with ovens specially designed for clean work, and a cupola for light castings, etc.

In the way of generators the company will continue to build to order the outside armature type, either slotted and with a separate commutator in large sizes, or smooth body with self-contained commutator in smaller sizes. The company will, however, continue to manufacture and to recommend in preference its inside armature machines, for which it now has many recent improvements. These are built with barrel windings, the end connections being supported by an end plate suitably ribbed to give ventilating passages through the coils. The company is now building of this type three 1,500-kw. machines for the North Western Elevated Railway of Chicago, five new 500-kw. machines for the Imperial Company of St. Louis, two 800 and fourteen 400-kw. machines and others of smaller sizes for other orders. In the way of smaller dynamos there are being developed lines of closed-coil arc machines, revolving field alternators, street railway motors, rotary converters and boosters.

A new line manufactured by this company is meters. Mr. Thos. Duncan, formerly with the Fort Wayne Electric Corporation, having joined the Siemens & Halske Company and brought with him the patent rights to the Duncan meter, which is now being manufactured in a new form called the improved Duncan meter.

Another new line is that of enclosed arcs, and still another is that of transformers, which are now being made in small sizes of the shell type, with sandwiched coils, giving close regulation.

The personnel of the company has been greatly changed by its recent reorganization: Mr. I. L. Rice, formerly President of the Electric Storage Battery Company, is now President of the Siemens & Halske Company; Mr. C. S. Knight, formerly of the Fort Wayne Electric Corporation, is Vice President and General Manager; assisted by Mr. A. Churchward, formerly of the Excelsior Electric Company, and more recently with the Fort Wayne Electric Corporation, who is chief engineer; Mr. Thomas Duncan is directly in charge of the meter department; Mr. F. L. Sessions is chief of the draughting department, and the staff includes also Mr. Thos. Drohan and other experienced designers, a large number of whom came with Mr. Knight from the Fort Wayne Company. Mr. C. E. Wilson is general Eastern agent for the Siemens & Halske Company, with headquarters at Philadelphia; Mr. F. A. Wunder is manager of the New York office; Mr. E. T. Pardee represents the company at Boston, Messrs. T. J. Ryan and T. C. Harnish at Cincinnati and W. R. Mason at St. Louis.



A VIEW IN THE SIEMENS & HALSKE SHOPS SHOWING WORK ON SOME LARGE MACHINES.

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# New Apparatus and Appliances

## THE BELDEN ENCLOSED ARC LAMP.

The reduction of the complication of automatic machinery to the lowest possible limits is especially imperative where such machinery is scattered, not under the immediate attention of experienced attendants and exposed to abuse and unfavorable climatic conditions. For this reason the development of enclosed arc lamps is not a simple problem and new and improved forms of lamps continue to appear on the market. The latest is one made by the Belden-Larwill Electric & Manufacturing Company of Ft. Wayne, Indiana, various views of the interior parts of which are shown in Figs. 1, 2 and 3.

The frame of the lamp consists of two tubes of cold drawn steel such as are used in bicycle frames, brazed to two circular steel stampings and supporting at their upper ends a hollow casting or sheave wheel housing, making a very rigid structure. The upper carbon holder is suspended within one of the tubes by a chain passing over a sheave wheel carrying a counterweight in the other tube. The sheave wheel is fixed to a hardened steel shaft that is fitted with ball bearings equal in every respect to those used in high grade bicycles.

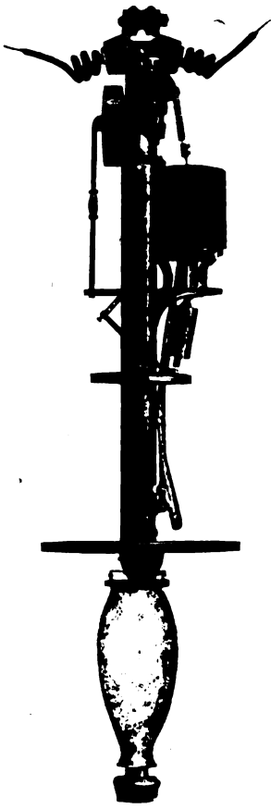


FIG. 1.—EDGE VIEW OF LAMP MECHANISM SHOWING TOGGLE.

The actuating magnet and mechanism, shown in Fig. 2, are self-contained and are connected to the lamp frame with a single screw. The iron core is drawn vertically into the solenoid or magnet, and being connected to a peculiar arrangement of lever and toggle movement, shown in the cut, the motion and force given to the clutch rod are uniform throughout its travel. The clutch rod carries at its upper end a U-shaped dog or clutch, shown in Fig. 2, tilted back from the projection, E, on which it normally rests. This clutch engages the flange of a wheel fixed to the projecting end of the sheave-wheel shaft already described, imparting to it a rotary motion which separates the carbons and strikes the arc. When the magnet core lowers, due to the burning away of the carbons, the clutch swings around with the wheel to such an angle that it releases itself without striking a trip post of any kind, thereby allowing the carbon to feed down.

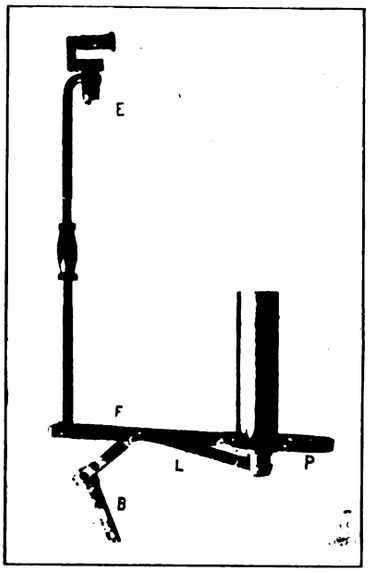



FIG. 2.—THE MOVING PARTS OF THE MAGNET AND CLUTCH MECHANISM.

The peculiar toggle joint arrangement of the parts, L, B and F, in Fig. 2, is to provide increased power when the plunger is well up within the solenoid and subject to a smaller pull per ampere of current in the coil. This gives a greatly increased range of motion on normal current and a positive separation of the carbons at the arc to three times the normal distance, a feature which eliminates the hissing and simmering of a short arc, common with other arc lamps in which a slight wear has made it impossible for the carbons to properly separate to the normal distance when the current is turned on.

The working parts are attached to each other by means of hardened steel triangular pins similar to those used in scales, which eliminates all likelihood of friction and sticking due to the parts getting out of alignment or becoming corroded or gummed by oil.

The greatest disadvantage occasioned by the introduction of enclosed arc lamps is that due to the high temperature which the parts near the arc attain and the consequent difficulty of handling them for retrimming when the lamp has been recently burning. This difficulty is eliminated from this lamp, as it may be retrimmed in any one of the following ways: 1st, by unscrewing the knurled cap at the bottom of the lamp; this being a part of the lower carbon holder, removes with it the burned out lower carbon, allowing the upper carbon to pass out through the same opening without the removal of the inner globe. New carbons may then be inserted into their holders in the reverse order. 2d, should the upper carbon be broken short in its holder, the stub may be removed by pressing the small latch at the back of the inner globe bracket, whereby it may be drawn down and turned to one side, giving free access to the upper carbon holder. 3d, by the same operation of removing the lower carbon holder the inner globe is released and can be removed by simply lifting it out. When cleaned and replaced the lamp may be trimmed as before.

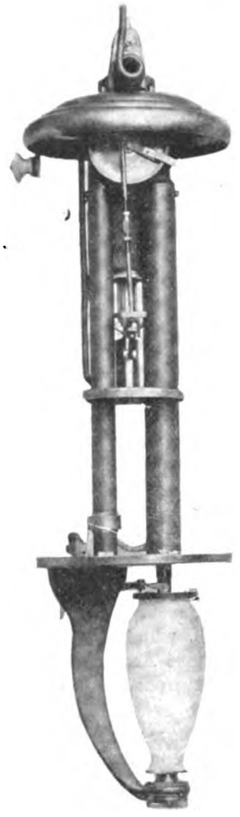


FIG. 3.—SIDE VIEW OF THE LAMP SHOWING CLUTCH.

The other advantages of the lamp may be summarized as follows: The springs usually employed in the mechanism of arc lamps have been eliminated, thereby securing a permanent adjustment at all times regardless of changes of temperature and length of time. There are no sliding contacts to corrode or cause trouble. The current is carried to the upper carbon by means of a flexible asbestos-

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covered cable. The peculiar construction of the dash pot allows the carbons to come together instantly in case the arc breaks or the current is shut off. No metal is used inside the inner globe, which is fitted with a carbon gas cap and bottom. This prevents the deposition of metallic vapors on the globe and consequent discoloration.

The lamp is the design of Mr. E. H. Belden, who has made a special study of the experiences of arc lamp users and the troubles found in this line of work, the new model being designed to, so far as possible, overcome the objections of older types.

### A GENERATOR FOR USE WITH GAS ENGINES.

The usual gas or gasoline engine of the type employing the Otto cycle gives necessarily a rather unsteady motion, due to the fact that there is per cylinder only one impelling stroke in two revolutions, and before each active stroke there is a heavy compression or power-absorbing stroke. In addition to this, the governor, if, as usual, of the hit-or-miss type, must move from one extreme to the other of its range every time the engine misses and again take a charge, which it is constantly doing at all times except when loaded up to its maximum possible capacity.

In order to prevent this pumping of the speed of the engine from making itself evident in the candle power of incandescent lamps it is customary to belt the engine to the generator with as much flexibility as possible and give to the latter a considerable fly-wheel effect in order to steady its speed of rotation. A countershaft is sometimes used in order to give two lengths of belt between the engine and dynamo, and even greater flexibility can be obtained by means of leather link or other belts which will run extremely slack.

Fig. 4 shows a generator made by the E. G. Bernard Company, Troy, New York, specially adapted for this work. So far as its magnetic and electrical features are concerned, the machine is similar to others of the same make, but structurally it differs in having a web fly wheel added. This fly wheel is placed on the commutator end of the machine, giving, with the pulley at the other end, a well-balanced rotating structure symmetrically arranged with regard to the two journals. In this respect the machine differs from many others designed for the same purpose which are fitted with a fly wheel integral with the driving pulley.

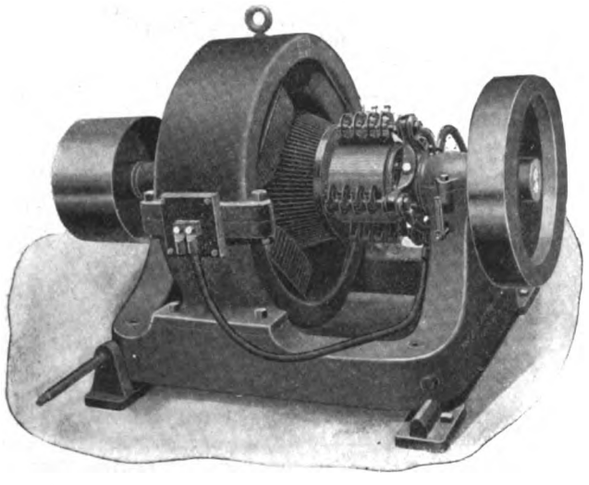


FIG. 4.—A FLY-WHEEL GENERATOR FOR USE WITH GAS ENGINES.

### A NEW MAKE OF RAILWAY GENERATORS.

The Bullock Electric Manufacturing Company, Cincinnati, Ohio, has commenced the construction of a new line of machines larger than those formerly built, viz., direct-coupled railway generators. These possess, as a rule, the features of the smaller machines made by the same house and have some new ones, among the more important of which may be mentioned a mechanism for oscillating the brush holders in a direction parallel with the shaft. The movement is a very slow one and results in constantly shifting the track of the brushes across the commutator face and preventing the cutting or grooving of the latter. The action is the same as that secured by the end play of an armature in a belted generator or that produced by the electro-magnetic device used at the ends of the shafts of rotary converters. The new machines have cast steel circular yokes with soft steel laminated poles. Each armature coil is a continuous bar of copper from tail to tail of the commutator segments. A machine already built of the largest size designed, viz., 800-kw., is shown in Fig. 5. These generators are fully described in Bulletin No. 0434.

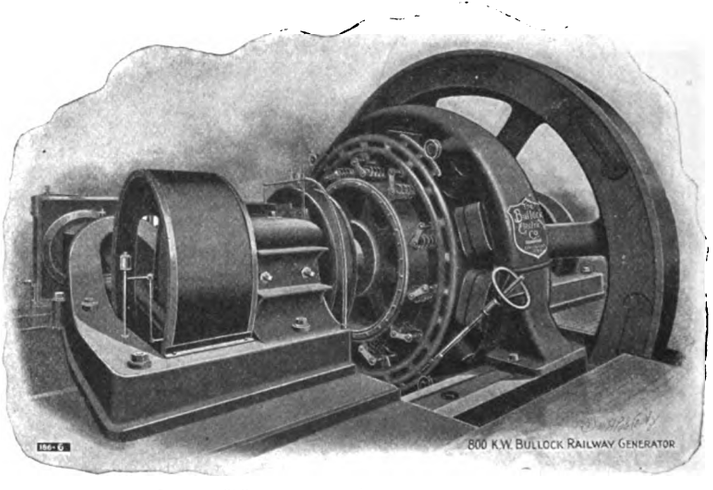



FIG. 5.—AN 800-K.W. BULLOCK RAILWAY GENERATOR.

### A PORTABLE PHOTOMETER.

The word photometer conveys to the mind of the average engineer the idea of a dark room containing a long and heavy bench on which are mounted scales, traveling carriages, lamps, mirrors, etc., a combination which at first thought would appear to be impossible to reduce to a portable form.

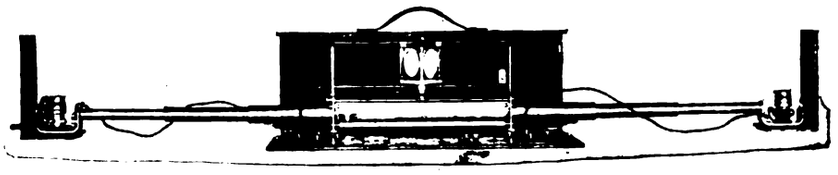


FIG. 6.—A SMALL AND PORTABLE PHOTOMETER.

Although portable photometers have been made containing the greater part of this apparatus, notably an oil burner, which is necessarily clumsy and inconvenient in such an instrument, the application of what is known as the "same circuit" method allows the simplification of the photometer to such a degree that it may be reduced almost to the dimensions and weight of a Weston measuring instrument. This method of photometric measurement is described on another page of this issue so that it is unnecessary to discuss it here. The portable photometer in which it is employed is shown in Fig. 6.

Structurally it consists of a box, the front side of which opens downwardly on the table or bench on which it is set, and holds the switches and circuit binding posts. The two ends of the box pull out with the lamp bases attached to them and are maintained at the proper distance and in alignment for photometric measurements by means of telescopic aluminum tubes. When the photometer is closed these tubes collapse into the cylinder on which is wound the resistance for adjusting the instrument to lamps of

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various rated voltages. This resistance is connected in series with the working standard and in contact with it is an adjustable slider working over a scale properly graduated to the voltage of the lamp under test; that is to say, if the lamp to be tested is rated at 112 volts the slider should be set opposite the 112-volt mark on the scale and will thereby insert sufficient resistance to bring down the pressure on the working standard from 112 volts to its rated voltage. As pointed out in the article above referred to, the determination of the candle power may be determined at this or any other voltage, constant or fluctuating, reasonably near it.

Three working standards are used, one for lamps between 50 and 60 volts, another for those between 100 and 120, and another for lamps above 200 volts, and 3 scales for the resistance slider are in place for these three standards.

The disc is of the grease spot type, mounted on a simple form of carriage fitted with cords by which it can be manipulated from the operator's position. The usual inclined mirrors to either side of the disc for reflecting the image of the grease spot forward are also tilted upward and backward so that the image is thrown upward and the operator need not stoop to the level of the instrument.

The receptacle of the test lamp is mounted for rotation and whirled by a bevel gear and a small hand crank to give mean horizontal candle power. Current is led to the lamp through silver collecting rings and silver tipped brushes, this metal being used since its oxide is not an insulator.

The working standard is a lamp of low efficiency, and consequently slow deterioration, burned or aged to make its candle power more constant, and is made with a coiled filament giving maximum distortion of the candle power distribution in a horizontal plane. The bulb is fitted with an arrow to indicate the proper direction in which it gives its standard candle power and this arrow can be changed from time to time when the working standard is recalibrated by comparison with a primary standard.

The whole apparatus is most ingeniously designed and worked down to minimum dimensions. Its weight complete with case is only 6½ pounds. It is made by the Bryan-Marsh Company, New York City, and was particularly gotten up for the educational work carried on by the lamp salesmen of this company among lamp users, although it is of practical value to a much wider class of electrical engineers.

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### AN IMPROVED CABLE HEAD AND DISTRIBUTING BOX.

In the running of telephone or telegraph lines wholly as overload separate wires insulated from each other and the ground by glass insulators and air, or wholly in the interior of lead-covered cables insulated by paper, paraffine or rubber, but little difficulty is found in eliminating disturbing currents and cross talk. But when the lines are partly in cables and partly open, as most lines nowadays must be, the point of junction is that of greatest weakness.

The interior of the cable must be hermetically protected from the weather and every conductor must be brought out from it in some way to the exposed open lines. Every conductor must further be protected by means of a lightning arrester to prevent lightning discharges from entering the cable, and fuses must be used to peep out high-pressure currents. The apparatus must be located in exposed positions, generally at pole tops, where dirt and moisture come in and corrode contacts, cause leakage between the parts, and consequently cross talk between the lines.

Fig. 7 shows a terminal designed to reduce these difficulties, and made by the Moon Manufacturing Company, Chicago.

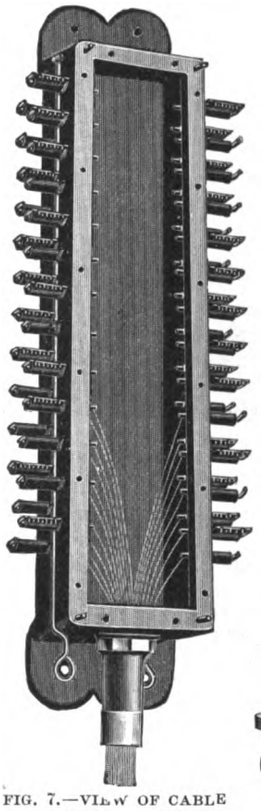


FIG. 7.—VIEW OF CABLE TERMINAL REMOVED FROM CASING AND WITH CAST-IRON COVER OF TERMINAL BOX REMOVED.

The cable head proper consists of a cast-iron box, within which the conductors of the cable are fanned out to their terminals, the box being then closed hermetically by a cast-iron front screwed on over a rubber gasket. Each terminal is forced to a tight fit in the side of the box, all being near a heavy vertical copper wire or rod, shown in the illustration, which serves as a lightning arrester. The terminals have slots or grooves, into which a channeled or corrugated fuse support may be slipped. The illustration shows some of the terminals with the fuse support in place and some without. The fuse is laced into the channels or partitions in the fuse support, so that although the distance in a straight line between its ends is but 1 in. the length of the fuse is 3½ ins.

The cast-iron cable head, with its fuses and lightning protective arrangements complete, is then enclosed in an outer casing of galvanized iron, the sides of which catch under lips on the back, so that the casing may be opened by sliding it vertically upward, this arrangement being far preferable to the usual doors on hinges which are likely to be left unfastened and fly open, allowing the rain to enter at any time. The sliding joint makes the casing quite moisture proof.

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### IMPROVEMENTS IN INDUCTION METER DESIGN.

The most prevalent faults in alternating current meters of the induction type are the entrance of dust, the weight and consequent friction of the moving parts, the pounding of the jewel or other support by vibrations set up by the alternating currents, the weakening of the permanent magnets by the influence of the alternating field near them and the loss of energy in the shunt circut.

In the meter shown in Fig. 8, which

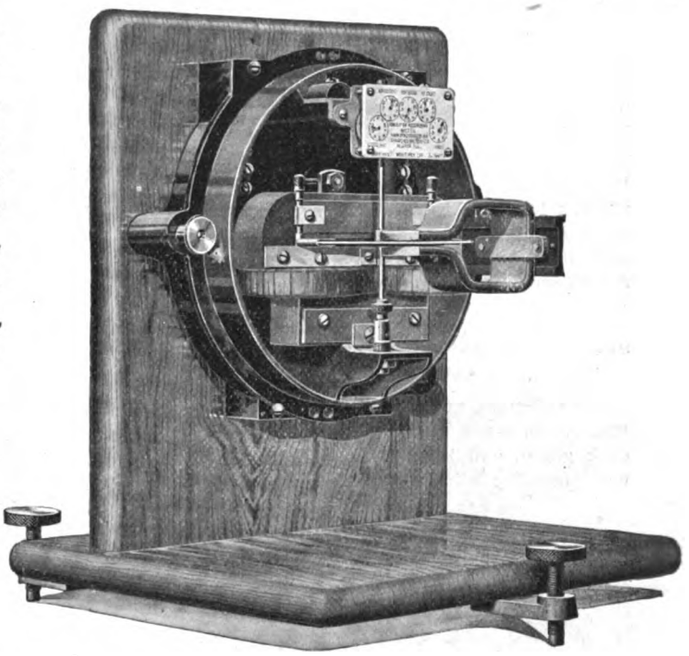


FIG. 8.—THE SCHEEFFER WATTMETER, WITH CASE REMOVED AND MOUNTED ON LEVELING CABLE FOR TESTING.

was designed by M. G. A. Scheeffer, and is manufactured by the Diamond Meter Company, Peoria, Ill., these faults have been eliminated or rendered negligibly small in the following ways:

The meter shell has been made cylindrical in form, as the illustration shows, the case of sheet metal being forced on over a rubber band or gasket, which surrounds a projecting flange from the frame of the meter, this flange tapering slightly so that the case when forced on makes a tight fit. The connecting or binding posts of the meter are covered with fibre bushings forced tightly into place through holes in the casting, making a tight fit

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at these points. The holes into which the connecting wires are inserted are not drilled through the binding posts. Thus the meter is practically hermetically sealed when the case is on, and is dust, moisture and bug proof.

Both the driving and braking elements of the moving part consist of one single light aluminum disc, greatly reducing the weight on the jewel. This disc runs between the coils carrying the alternating currents at the back of the meter and between the poles of the retarding magnet in the front of the meter, thus serving both functions.

It is claimed that the loss in the shunt circuit amounts to only ½ watt on 125 cycles and ¾ watt on 60 cycles, the small amount of power so used not only being an economical feature, but reducing the pounding of the jewel and the stray field which weakens the permanent magnet.

The series coils consist of a few turns of wire without any iron core, and therefore with small inductive drop, and give the meter a straight line characteristic, which insures accuracy even with excessive overloads, as there is no iron to be over-saturated. The drop through the meter at full load is claimed to be only about 1/10 of a volt.

Embracing the disc at each side of the center is a small shield, these shields tending to give the disc an initial torque in opposite directions regardless of the load. This torque may be accurately balanced between the two or by slightly twisting either one or both the meter may be given a tendency to turn in the right direction sufficient to balance the friction and allow a very slight percentage of the rated current to start the mechanism.

### MIRROR REFLECTORS FOR INCANDESCENT CLUSTERS.

The reflectors, one of which is shown in Fig. 9, are made of heavy tin, japanned dark green, and lined with glass plated with metallic silver, the plating being protected by a coating rendering it impervious to moisture or other injurious surroundings. The glass gives a surface which does not tarnish and is readily cleaned. The reflecting surface is made up of a large number of sector-shaped facets, any one of which is easily replaceable when broken by bending the bronzed lead edge which holds them in place.

Reflectors of this style are made by the American Reflector & Lighting Company, Chicago.



FIG. 9.—A REFLECTING MIRROR ON AN INCANDESCENT CLUSTER.

### TELEPHONE PROTECTIVE DEVICES.

For the protection of delicate instruments, such as telephones, connected to overhead lines, against both lightning and powerful currents, a device combining a fine fuse with a narrow air gap to ground has become standard. The fuse is generally mounted on a strip of mica or pasteboard, with small extensions of tinfoil in contact with the fuse, and glued to the ends of the strip in such a way that they will come in contact with clips or jaws into which the whole may be readily inserted.

The protection against lightning takes the form of two carbon plates, one connected to the line and the other to ground, pressed together by springs and separated by a thin sheet of mica or paper, preferably perforated, the separation maintaining open circuit between line and ground across which the lightning can readily jump.

The accompanying illustration, Fig. 10, shows one form of double-pole combination fusible cutout and carbon lightning arrester on a porcelain base intended for independent instrument protection on metallic circuits and made by the Harvard Electric Company, Chicago, Ill.

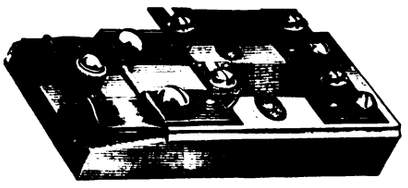


FIG. 10.—A DOUBLE-POLE PORCELAIN CUTOUT AND LIGHTNING ARRESTER FOR TELEPHONE LINES.

This device is also made up in a single-pole form for instruments used on grounded or common-return circuits, as well as in banks for use at the switchboard of the exchange.

### A NON-MAGNETIZABLE WATCH.

For those whose watches are affected by the stray fields of dynamos and motors near which they work, the watch represented in Fig. 11 has been especially designed. The hair spring and balance are not made of steel, palladium being used in its place. An incidental advantage of this metal is the fact that it will not rust. The balance is also compensated for extreme temperature changes. The watch is made by A. C. Becken, Chicago.



FIG. 11.—THE WORKS OF A WATCH WITHOUT A STEEL HAIR SPRING.

### NEW TELEPHONE APPARATUS.

A new form of granular transmitter, in which some objections to older forms have been overcome, is illustrated by the cross section shown in Fig. 12. From this section it will be seen that the transmitter proper or cartridge is assembled and screwed together entirely separate from the outer casing and may be removed and cleaned by any inexperienced person without disturbing the adjustment of its parts. This construction is accomplished by fitting the diaphragm and carbon parts in an inner metal casing independent of the outer metallic shell, a threaded ring fastening the diaphragm in place whether the cap holding the parts is screwed down upon it or not. The solidity of construction obtained in this way obviates the necessity of any adjustment of the instrument after it leaves the factory, even if the shell receives considerable knocks or is indeed forced to a certain extent out of shape.

The transmitter is made by the Tucker Manufacturing Company, York, Pa., which has equipped its factory to manufacture every part that goes into the construction of telephones and is prepared to furnish complete exchange instruments. The company's apparatus includes some other improved parts, among them novel forms of transmitter arms and receiver hooks.

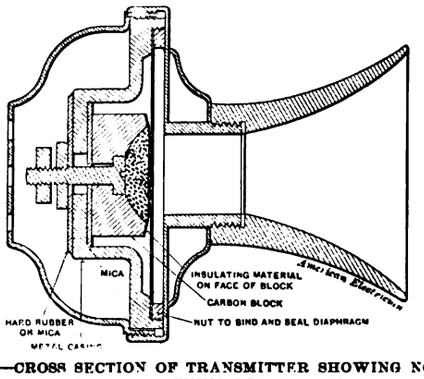



FIG. 12.—CROSS SECTION OF TRANSMITTER SHOWING NOVEL MEANS OF FASTENING DIAPHRAGM.

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### AN AMMETER OR VOLTMETER SWITCH.

It is customary when using many independent machines or bus bars or bringing pack pilot wires from several points of distribution to arrange a switch in such a way that one voltmeter can be transferred to any pair of wires in order that it may measure the pressure from any one of several sources. The Weston ammeter of

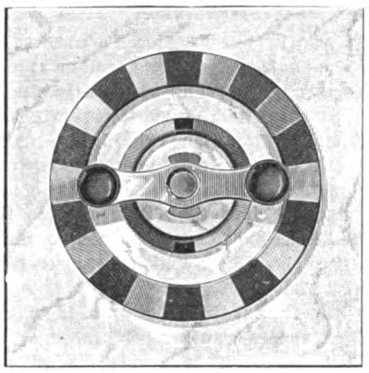


FIG. 13.—A SWITCH FOR THROWING A VOLTMETER OR AMMETER TO ANY ONE OF SEVERAL CIRCUITS.

the switchboard type is nothing more nor less than an extremely low-pressure voltmeter connected by shunt cords to the terminals of a low-resistance shunt carrying the current to be measured. The instrument proper simply measures the fall of potential in this shunt, which is of course proportional to the current flowing. On this account a switch exactly like that used for voltmeters could be connected to an ammeter and various shunts located in the different circuits in such a way that the one instrument would measure the current in any one of them according to the position of the handle of the switch. Owing, however, to the very low voltage of the instrument circuit the switch when so used must have highly perfect contacts, as any imperfection in this respect would utterly ruin its indications.

The switch shown in Fig. 13 was designed by Mr. J. W. Mabbs, engineer of the Chicago Board of Trade, for this service. As may be seen, it consists of a pair of semi-circular contacts forming an inner ring and connected to the instrument terminals, and a number of insulated segments forming an outer ring, there being twice as many of these segments as there are circuits to be connected. The rotating arm is double pole, the two halves being insulated from each other although the illustration does not indicate this. By moving it from segment to segment, the instrument may be connected with any one of the desired circuits. Forcible contact is made with the inside cylindrical faces of the outer segments, giving a path of very low resistance. The insulating divisions between the outer segments are of ample width to prevent cross connection when the contact passes from one to another.

When used with a voltmeter the switch allows the transformation of the one instrument to a ground detector from either bus. When used with an ammeter it allows the one instrument to be thrown on to any circuit, giving a means of measuring the output over any feeder at will, which measurement is at times extremely desirable, but is not, as a rule, considered enough so to warrant the expense of an instrument in every circuit. The switch should also prove useful as a synchronizing switch in alternating-current plants.

### A FEED WATER FILTER AND OIL SEPARATOR.

All condensing steam plants returning the condensed exhaust from the hot well to the boilers as feed water, or non-condensing plants using open feed water heaters in which the feed water is heated by the intermixture of exhaust steam, require some device for eliminating the cylinder oil from the exhaust or feed water to prevent the gradual accumula-

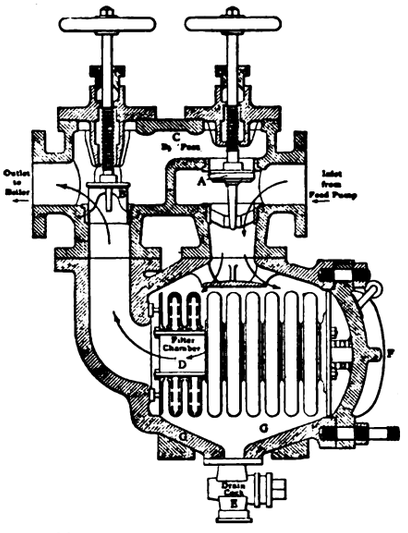



FIG. 14.—A SECTIONAL DIAGRAM OF OIL SEPARATOR, SHOWING BYPASS AND REVERSING VALVES.

tion in the boiler of the oil constantly pumped into the cylinders.

In marine engine practice, where the same water is necessarily used over and over again, it is customary to use filters of a type in which the water is strained through some fabric which retains the oil but allows the water to pass. A filter of this kind now on the market for land as well as marine practice is shown in Fig. 15, the details of its construction being shown by the vertical section Fig. 14.

The fabric used is Turkish toweling in the shape of a large bag, which is drawn over a skeleton made of circular bronze sections of open lattice work shown separately in the left-hand side of Fig. 15. The bag is drawn down between the circular sections by strings and the whole is then inserted in the filter in the position shown in the diagram. This manifolding or fluting of the toweling gives a large area for the water to pass through, from 250 to 1000 times that of the feed pipe, and consequently a slow velocity through it, in minimum space occupied.

The water enters, as the arrows indicate, through valve A, passing through the filtering material and out through valve, B, to the boiler. The oil or other matter separated accumulates on the outer side of the filtering material and gradually increases the resistance to the flow, this resistance being indicated by the difference between the readings of the two pressure gages shown in Fig. 15. When this difference reaches two or three pounds the filter may be cleaned by reversing the flow of water or by renewing the skeleton and bag through the removable head with the aid of the handle shown attached to the skeleton in Fig. 15. To provide for this removal the valve, A, is fitted with a face on each side of its disc which may be closed on either an upper or lower seat. With the disc down and the valve, B, closed, the feed water is by-passed around the filter, which may then be opened for removal of the clogged toweling. The same ingenious arrangement of valves allows for the reversal of the flow. This is done by closing A and opening the drain cock at the lower part of the filter and valve B. The water then flows outwardly through the filtering material, carrying the oil with it into the drain pipe.

These filters are made by the Ross Valve Company, Troy, N. Y., for use on some of the largest transatlantic steamers, the latest being the Oceanic of the White Star Line, and also for many steam power stations on land.

### THE GAS ENGINE OF THE COLUMBUS MACHINE COMPANY.

Among the particular features of the engine illustrated in Fig. 16 is the method of operating the valves and governing

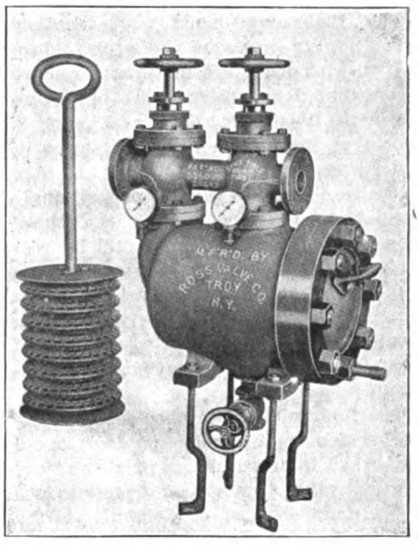


FIG. 15.—A VIEW OF OIL SEPARATOR, SHOWING LATTICE WORK SKELETON REMOVED.

mechanism, the power for which is communicated from the main shaft by means of spiral gears operating a horizontal shaft extending along the side of the engine. At the end of this side shaft near

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the head of the cylinder of the engine is a clutch cam which is given an intermittent motion by means of the governing mechanism. This cam operates the fuel and exhaust valves, which are located in removable cases beneath the rear end of the cylinder, by means of arms which are made adjustable to take up any wear of the cam. The valves are of the poppet type and the cams are backed off so that

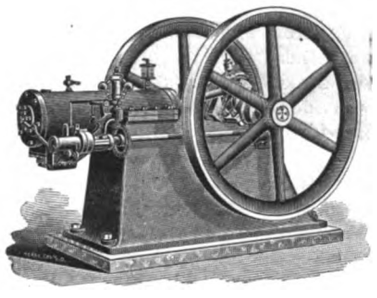


FIG. 16.—A GAS ENGINE CAPABLE OF MAKING HALF IDLE CYCLES.

when the valves are seated it is accomplished without sudden shock to the valve, thus reducing wear and breakage.

It is a fact well understood by those familiar with gas engines that in the single cylinder hit-and-miss-type of engine, which is the most common of all, when the engine cuts out its fuel it is necessary to complete the cycle revolutions at least before the engine can again take an impulse. Where close regulation is necessary and where an engine is working close to its rated capacity, the speed may have become accelerated sufficiently for the governor to act and cut out, yet in a single revolution the speed may drop sufficiently to allow another impulse, were it possible to obtain one. Not being able to do so, the engine must make another revolution to complete the cycle before the working parts are in time to receive a new impulse. On the type of engine herewith illustrated the clutch cam is such that the governor may act upon it, causing it, after having cut out, to take up its load again at the end of any single revolution, thus preventing the speed from dropping more than would be possible while the engine was making one single revolution of the fly wheels. This is a feature which is entirely new in a single cylinder, hit-and-miss engine and it contributes to the closest possible regulation.

The fuel valve is another special feature of this engine and is so constructed that when taking a charge of air and gas the air valve has a lead over the gas valve, thus operating economically in the consumption of gas. This lead of the air valve over the gas valve can be varied by simple adjustment.

The cylinder of this engine is constructed with a solid explosion head, dispensing with any packed joints, and is provided with a very liberal water space around the valves and cylinder.

The Columbus Machine Company, Columbus, Ohio, is building these engines at the present time up as high as 60 h. p., but expects to add still larger sizes during the coming season.

### A NEW FORM OF EXHAUST HEAD.

One of the important features of a non-condensing steam plant is the exhaust steam pipe head. Its purpose is the same as that of a steam separator, viz., to extract the water from the steam, and thereby prevent the constant spraying of roofs and walls with consequent deterioration and expensive repairs. In the form of exhaust head built by the B. F. Sturtevant Company, Boston, Mass., and illustrated in Fig. 17, the principle of centrifugal force is utilized to secure a high degree of separation.

Dry exhaust steam weighs only .038 lb. per cubic foot, while water of the same



FIG. 17.—AN EXHAUST HEAD CONTAINING A CENTRIFUGAL SEPARATOR.

temperature weighs 59.36 lbs. per cubic ft. It is therefore true that particles of water in the exhaust will be thrown outward with 59.36/.038 or 1562 times the force exerted upon steam occupying the same volume. In the Sturtevant exhaust head the steam passes up the interior pipes, is discharged tangentially close to the shell, and is thereby given a vigorous whirling motion. The entrained water—likewise the oil—flies outward, strikes the cool side and trickles down to the outlet at the bottom. The steam, now dry, finds ready escape through the central opening above. The action is simple and effective.

These heads are built in sizes to fit pipes from 1 inch to 20 inches. All sizes above 10 inches are flanged instead of tapped.

### THE CORNELL INTERNAL COMBUSTION ENGINES.

For use in small isolated plants there is a demand for a gas or gasolene engine of close regulation and sufficiently simple in character and easy to operate and maintain for the attendants in such plants who are, as a rule, janitors or porters, men of ordinary intelligence but no mechanical ability. For this service the Cornell Machine Company, Chicago, manufactures the engine which is represented in Fig. 18.

As the illustration shows, it is of the vertical center-crank type, and has the usual features of such engines, poppet valves, hit-or-miss governing and so forth. The cooling water in the jacketing passes around the valves before it reaches the cylinder, thus insuring cool valves. The latter are removable by loosening two screw plugs in the top of the valve casing, this also exposing the ignitor, which is of the electrical wiping spark type. The entering air for each charge passes over the electrodes, serving to keep them clean and cool. When the speed of the engine rises so that the governor cuts off the charge the exhaust valve is held open, thereby avoiding compression and expansion on idle cycles and consequent loss of power by unnecessary friction.

Tests made with an engine of this make supplied with gasolene and of only 2½ h. p., belted to a 1½-kw. dynamo, are claimed to show no noticeable flicker and a variation of less than three-fourths of 1 per cent. of the voltmeter reading, as well as steady deflection of a tachometer on a variation of half the rated load.

The engines are built in sizes ranging from 2½ to 50 h. p.

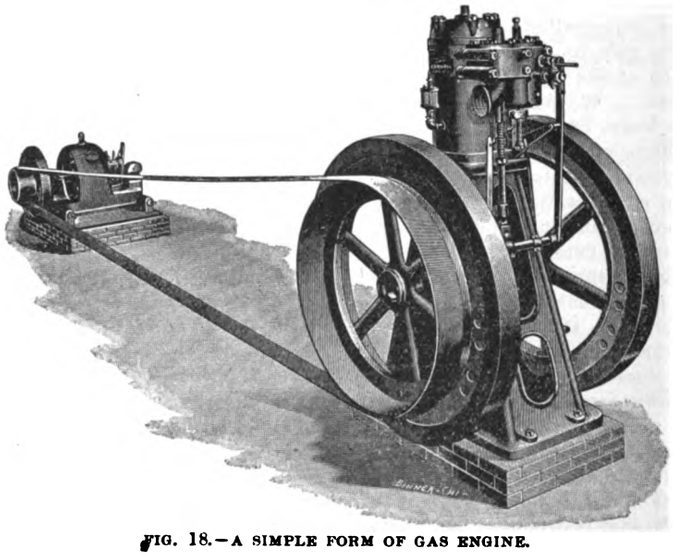


FIG. 18.—A SIMPLE FORM OF GAS ENGINE.

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SIGHT FEED DEVICE FOR BOILER COMPOUNDS.

In the lubrication of engine cylinders it was at one time generally customary to introduce the oil by means of a hand pump, or otherwise, in considerable quantities at intermittent times. It was soon found that a greater economy of oil as well as much more efficient lubrication was obtained by introducing it continuously, drop by drop, by means of sight feed devices or constantly driven pumps. In the same way it has been customary to introduce into boilers the compounds designed to prevent the vaporizing surfaces from corrosion and scale in quantities of a quart or more from time to time, and it is now coming to be a recognized fact that the application of the compounds should be continuous in small quantities, rather than intermittent in larger quantities.

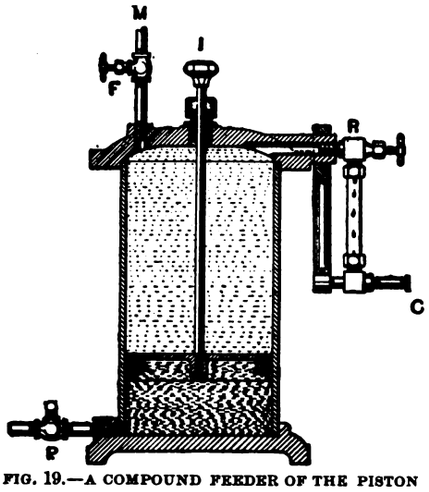



FIG. 19.—A COMPOUND FEEDER OF THE PISTON TYPE.

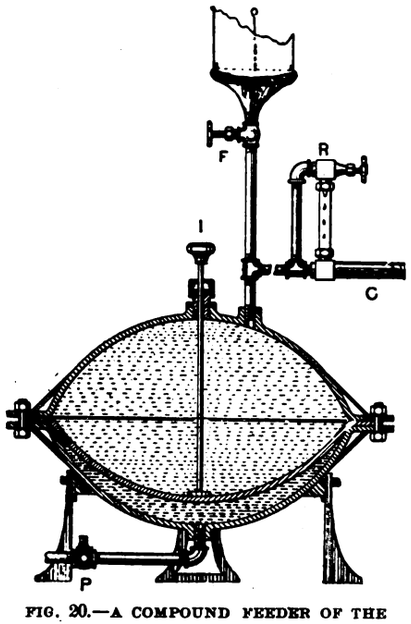



FIG. 20.—A COMPOUND FEEDER OF THE DIAPHRAGM TYPE.

A piece of apparatus for feeding boilers drop by drop with any liquid compound designed to protect the vaporizing surfaces from corrosion and scale, its operation being practically analagous with that of sight feed lubricators on engines, is shown in Figs. 19 and 20, the former showing a piston and the latter a diaphragm form.

When in operation the three-way valve, P, is connected with the pressure side of the feed pump and also with the drain, so that water may be forced in below the piston or diaphragm and again released by manipulating the valve. The space above the piston or diaphragm may be filled with the compound through the valve, F, the piston or diaphragm being simply forced down to eject the water below it by the pressure of the hand upon the top of the indicating rod, I. The upper space once filled with the compound, the pressure of the feed is applied to the lower side of the piston or diaphragm and the compound is driven out through the valve, R, and the sight feed glass to the suction side of the feed pump. By adjusting the valve the required number of drops per minute may be obtained.

A feeder of this kind allows the material to be introduced continuously at any desired rate. The apparatus is made by the Hall Compound Feeder Company of Chicago.

## NEW BOOKS.

The Slide Valve. By W. J. Tenant. Revised and enlarged by J. H. Kinealy. New York: Spon & Chamberlain. 83 pages, illustrated. Price $1.00.

This practical handbook on the slide valve contains some new devices intended to simplify the discussion of this pons asinorum of the student of the steam engine. One of these is a circular diagram of the arcs swept through by the crank during the periods of admission, expansion, exhaust and compression. Another is a diagram containing scales by which the position of the valve on the valve seats can be reduced to the position of the eccentric as well as to the position of the crank. The work is an elementary one, only touching upon the more complicated features of valve gear, such as the Stephenson link and automatic cut-off arrangements, but giving valuable notes explaining some well known valves widely used in this country, such as those of the Watertown, Buckeye and Ide and Ideal engines.

The Internal Wiring of Buildings. By H. M. Leaf. Philadelphia: J. B. Lippincott Company. 195 pages, illustrated. Price, $1.50.

This admirable text book on wiring is unfortunately not as valuable for practical use in this country as in England, the author being an Englishman, and the fittings and arrangements described being those of standard English practice. It is, however, very thoroughly written, handsomely illustrated, and of interest to those going more deeply into the subject of wiring than does the ordinary wireman or contractor, and wishing to know the best practice of other countries as well as our own. The art of interior wiring is perhaps in England behind that in America, the use of iron armoured conduit being comparatively rare, although in some directions, notably the use of concentric systems, English practice has developed in different lines from American and may therefore give valuable suggestions. The work contains the English insurance regulations, as well as those of some of the more important electric lighting companies.

Mechanical Movements. By Gardner D. Hiscox. New York: Norman W. Henley & Company. 380 pages, illustrated. Price $3.00.

This work might well be called a dictionary of electrical movements, powers, devices and appliances used in constructive and operative machinery and in the mechanical arts. It consists of 1649 definitions of mechanical devices, each illustrated by a drawing. A small section, 16 pages, is devoted to electrical appliances in which some 56 attempts at definitions are made. These purport to cover the whole field of electrical engineering, and include a general hodge-podge of telephone, railway and lighting apparatus from a flexible coupling to an electrical sad-iron. A double pole generator is called a single pole generator; a ring armature with 4 coils is called a 4-pole ring armature, and the definitions generally exhibit an utter lack of knowledge on the subject. They are evidently a collection of descriptions of various line cuts that have been found available for reproduction in books, periodicals and other places; these cuts being, as a rule, antiques of the most ancient order. A magneto-electric machine shown is one of the old hand-driven medical machines of twenty-five years ago; under street railway motor equipment there is illustrated a single motor driving the two axles through bevel gears; and the electric car brakes and other devices are just as impracticable and utterly unrepresentative of any commercial work. The only value of a work of this kind is as a sort of a dictionary, in which the index is of fundamental importance. The index of this work is, however, so poor that it is no guide to what little information there is embodied in the definitions.

## OBITUARY.

PROF. ROBERT WILHELM EBERHARDT BUNSEN died August 15th at Heidelberg, Germany, at the age of 88 years. Prof. Bunsen's life has been such a long and active one and so many of his achievements were made in early years that many of the present generation of engineers will be surprised that he was until recently living. Bunsen's name is most widely perpetuated in that common device, the Bunsen burner. Prof. Bunsen did much to advance the scientific comprehension of electrical phenomena, particularly in the early days of this branch of science. He is also known for his original work in the field of spectrum analysis.

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## PERSONALS.

MR. GERARD SWOPE, formerly of the engineering department of the Western Electric Company, Chicago, now represents this company in St. Louis, Mo. The office is No. 10 Security Building.

ELECTRICAL MEN HOME FROM ABROAD.—On the first trip of the largest ship in the world, the "Oceanic," arriving in New York, Sept. 13th, were several well known men in the electrical industries who had been abroad. Among them were President Chas. A. Coffin of the General Electric Company, General Manager G. G. Ward of the Commercial Cable Company, and Frank J. Sprague of the Sprague Electric Company.

MR. P. M. HELDT, well known to the readers of the American Electrician through his contributions to its columns, was until recently connected with the Munson Company of La Porte, Indiana, and designed this company's combined gasolene and motor-driven automobiles, recently described in the American Electrician. Mr. Heldt is now associated with the Western Electric Company of Chicago.

A. F. McKISSICK, formerly professor of electrical engineering in the Alabama Polytechnic Institute, has resigned his position and accepted that of engineer in charge of the Pelzer Manufacturing Company's electric plant at Pelzer, S. C., which is by far the largest installation in the South of hydraulically-driven apparatus for the electrical distribution of power throughout a manufacturing establishment.

## TRADE PUBLICATIONS.

A TOAST TO ADMIRAL DEWEY is attractively pictured on a handsomely engraved card sent out with the compliments of the John A. Roebling's Sons Company of New York.

THE GENERAL ELECTRIC AUTOMOBILE COMPANY, Philadelphia, is circulating a small pamphlet illustrating its delivery wagons, run-abouts, Stanhopes and broughans.

THE WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY has brought out three new bulletins, respectively describing and illustrating multipolar generators and motors, adjustable jaw type switches and plunger type switches.

THE ELECTRIC APPLIANCE COMPANY, Chicago, attributes its success with Noxall annunciators to two points—their simplicity of construction and the price. A circular the company has just issued gives a good description of this instrument.

THE NOVELTY ELECTRIC COMPANY, Philadelphia, is preparing for general distribution a handsome catalogue that will be devoted exclusively to electric light material. This same concern issued last spring an elaborate catalogue on house goods.

THE WESTERN ELECTRIC COMPANY has on the press a bulletin fully describing hot wire ammeters and voltmeters. These instruments may be used upon either direct or alternating current, and are made either for switchboards or of the portable type.

J. B. COLT & COMPANY, New York City, have published a very handsome illustrated catalogue of the Criterion automatic acetylene gas generator, and accessories. The catalogue contains also the complete insurance regulations covering acetylene apparatus.

JOHN S. NOWOTNY, Cincinnati, Ohio, has brought out a new catalogue on his long burning arc lamps. A feature of this lamp is the adjustable armature in the solenoid by which the length of the arc can be changed and the current consumption varied between 3½ and 5 amperes, the candle-power varying with it.

THE ERICSSON TELEPHONE COMPANY, New York City, has started the publication of a small pamphlet entitled the "Ericsson Series." This is intended to cover valuable telephone information in convenient form for reference and future use. Part I of Vol. 1 contains diagrams showing the circuits of series and bridged telephones.

ELECTRIC MINE HAULAGE.—A catalogue upon underground electric haulage has been issued jointly by the Baldwin Locomotive Works and the Westinghouse Electric & Manufacturing Company. The catalogue illustrates and describes the locomotives, and contains tables of dimensions, and of the hauling capacity upon various grades.

THE HOPPES MANUFACTURING COMPANY, Springfield, Ohio, has published a new catalogue of its steam separators and oil eliminators and feedwater purifiers and heaters. The catalogue is illustrated with perspective views of the apparatus described with the shells broken away so that the construction of the devices is made most clear.

THE C. J. TOERRING COMPANY, Philadelphia, manufacturers of the Toerring enclosed arc lamp described in the last issue of the American Electrician, has recently issued an illustrated catalogue covering its 200-hour enclosed arc lamps. The company claims that in no recent lamp tests has it obtained less than 225 hours' life, using one 12x½ in. carbon.

THE AMERICAN REFLECTOR & LIGHTING COMPANY of Chicago is circulating a new catalogue of its extensive line of reflectors and shades, pointing out the merits of the forms and materials used, notably the opal porcelain glass which is semi-transparent, and the corrugated silver glass, which has a high reflecting surface giving a mellow light owing to the diffusion given by the corrugations.

GATES & RANDOLPH, Chicago, Ill., have published a 20-page catalogue in bulletin form of the chief lines of apparatus which they handle and install in their work as engineers and contractors for electric railway, light and power plants. The catalogue describes and illustrates Triumph direct current machines, Warren inductor alternators, Empire instruments, Scheeffer transformers and meters, La Roche circuit breakers and switches, Sterling arc lamps, Bristol recording instruments and Nash gas engines.

THE B. F. STURTEVANT COMPANY, Boston, Mass., has brought out catalogue No. 101, entitled "Steel Plate Planing Mill Exhausters." These machines are adapted to a much wider class of use than the name indicates, as they may be used for the handling of all classes of material light enough to be carried by an air blast. The Sturtevant enclosed motor combined with these exhausters makes a most suitable arrangement for the dust laden locations where such machines work whenever mechanical power is not available.

THE WARD LEONARD ELECTRIC COMPANY, Bronxville, N. Y., has published catalogue No. 997, illustrating its principle types of rheostats and circuit breakers. The line is a comprehensive one, including in addition to the conventional lines of field rheostats, theatre dimmers and motor controllers, some more interesting and special apparatus, such as motor driven dimmers, motor starters with combined automatic no voltage release and interlocking overload circuit breaker, storage battery regulators, printing press speed controllers, etc.

WILLIAM BARAGWANATH & SON, Chicago, Ill., have issued a new catalogue of feed water heaters, and jet condensers of their well-known types. As most users of such apparatus know, they make a closed feed water heater in both the vertical and horizontal types, as well as the plain tubular heater and open heaters, both upright and horizontal, and with and without receiving tanks. The Baragwanath siphon condenser of the jet type requiring no air pump, the vacuum being obtained solely by the fall of the water from the jet to the hot well 34 ft. below, is also listed in this catalogue.

THE ELECTRICAL ENGINEER INSTITUTE OF CORRESPONDENCE INSTRUCTION, New York City, has brought out a catalogue of its electrical engineering, mechanical engineering and other courses. The list of courses is a surprisingly well rounded one, containing besides the elementary or general and popular courses usually desired by students of correspondence schools, a line of advanced technical special courses, such as those in advanced telephony, electric mining, railroad signaling and train dispatching, electrometallurgy, storage battery practice, electro-therapeutics, medico-surgical radiography, etc.

THE MONTAUK MULTIPHASE CABLE COMPANY, New York City has printed a revised price list No. 3 and an "Installation and Specification Handbook." The latter not only describes the cable and shows how to install it by means of complete diagrams of circuits and other directions, but also gives forms for making estimates and methods of making out proposals so that all an installing electrician needs to know in regard to complete installations using this cable can be found in the book. The price list supersedes all others and lists many new styles of cable, besides containing other data useful to the installing electrician.

THE LOMBARD WATER-WHEEL GOVERNOR.—The Lombard Water-Wheel Governor Company, Boston, has issued a pamphlet describing its new type F governor, which has been designed for application to Pelton and other makes of impulse water-wheels, and for the regulation of small turbines. A concise general description of the new governor is given, and also clear instructions as to data to be furnished to the manufacturers when ordering. A letter is printed from the superintendent of the celebrated Redlands plant in California, which speaks in the highest terms of the performance of the Lombard governor in that plant.

THE STRAIGHT LINE ENGINE COMPANY, Syracuse, N. Y., has brought out the tenth edition of its catalogue under date of July, 1899. The catalogue gives an admirable exposition of the peculiarities which have made the Straight Line engine famous, among them the three self-adjusting points of support, the packingless piston and valve rods, the cross-head pin tight in the connecting rod, the long cross-head and short guides, the throttle, the limited expansion piston rings, the flexible strap to the governor spring and the straight uniform frame on each side from cylinder to main bearings, which has given the engine its name.

THE JOSEPH DIXON CRUCIBLE COMPANY, Jersey City, N. J., has brought out a new catalogue of Dixon's graphite productions. Besides its pure flake graphite, which is of great value for engine lubrication, and its paints which are of value for telegraph and trolley poles, smoke stacks, boiler fronts, etc., quite a number of graphite products are now made solely for the electrical trade. Among these are graphite boxes for baking carbon lamp filaments, etc., as well as graphite "forms" in wedges and other shapes on which to wind lamp filaments, and ground graphite for use in baking the carbons and filaments, its value in this process being to absorb the oxygen which would otherwise attack the more valuable materials. The company also makes its well known resistance rods up to 2 ins. in diameter and 12 ins. in length with any resistance between 1 and 7,000,000 ohms. A special graphite is also made for cementing the filaments of incandescent lamps to the leading in wires. Other forms are made for use in battery plates.

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THE ELECTRIC RAILWAY NUMBER OF CASSIER'S MAGAZINE.—One of the most elaborate and handsome specimens of magazine literature that has ever made its appearance is this special issue of Cassier's, which was recently published. It comprises altogether 18 articles prepared by 18 authorities in electric railway work, and is if anything an advance on the two remarkable special numbers of the same magazine previously published, viz., the Niagara Power and Marine numbers.

THE EMERSON ELECTRIC MANUFACTURING COMPANY, St. Louis, has brought out two new bulletins, Nos. 3,002 and 3,003, dated September, 1899. The first lists nearly a thousand different sizes and types of marble tablet boards, comprising a complete line in which practically any board wanted can be found. The second describes the small power alternating current induction motors for single-phase circuits, these motors now being made in sizes from 1/10 to ¼ h. p. for four different frequencies, 6,000, 7,200, 12,000 and 16,000 alternations per minute, making in all 13 different machines of this style, any one of which can be ordered for either 52 or 104 volts.

THE WESTERN ELECTRIC COMPANY has published a catalogue of power motors describing, illustrating and listing its encased, semi-encased and open machines as well as its back-gear motors and motor generators. The Western Electric motor of the enclosed, or as the company prefers to call it, encased type, has one ingenious peculiarity in its mica windows in the covers fastened to the bearing bracket, through which windows the commutator and brushes can be examined at any time. In the matter of field windings this company makes its compound wound motors in two styles termed respectively quarter compound and half compound; the former style, as the name indicates, is one in which the series coils occupy 25 per cent. of the total volume of the field winding, this ratio giving a reduction of the speed by 15 per cent. from no load to full load. In the half compound style the series coils are equal in volume to the shunt, these motors dropping about 40 per cent. of the speed over the rated load range.

WILBUR B. DRIVER & COMPANY, New York City, have issued a price list of "Climax," "Advance" and "D" resistance wires. Complete tables of the electrical and physical properties of the wire are also given. "Climax Wire" has about 48 times the resistance of copper, which is about three times that of German silver and six times that of ordinary steel. This high specific resistance renders it an economical substitute for rheostat work, especially where it is subjected to repeated heating and cooling, which renders German silver brittle and liable to breakage and open circuit. The carrying capacity of the various sizes of "Climax Wire" as well as the resistance per 1000 ft. are given in tables for every 100 degrees up to 1000 degrees F., which indicates the remarkable ability of this material to maintain its physical properties at high temperatures. "Advance" wire has about 30 times the resistance of copper, and its coefficient is practically nil, making it especially valuable for use in measuring instruments. "D" wire has about the same resistance as 18 per cent German silver, and is claimed to be stronger, less liable to corrosion and with a lower temperature coefficient. The catalogue also lists a new steel wire with a remarkably low temperature coefficient, viz., .04 per cent per deg. F.

## BUSINESS NEWS.

THE E. P. ALLIS COMPANY, Milwaukee, Wis., has leased the Lake Erie Engineering Works at Buffalo, N. Y., and expects to have 500 men at work there by September 1.

THE THRONATEESKA ICE, LIGHT & POWER COMPANY, Bainbridge, Georgia, is about to purchase a 75-kw. alternator and a 50-kw. power generator and wishes to receive tenders for the same.

THE MOUND TOOL & SCRAPER COMPANY, St. Louis, Mo., made for the Garlock Packing Company 1,000 souvenir packing tools which were given away at the annual convention of the National Association of Steam Engineers.

PASS & SEYMOUR, Syracuse, N. Y., have opened an office in Boston at 22 Summer St., in the New England Building, where they intend to carry a full stock of their porcelain goods. The new office is in charge of Mr. A. B. Field.

MESSRS. PARTRICK, CARTER & WILKINS, Philadelphia, the manufacturers of annunciators and bells, as well as of other electrical house goods, are arranging to have a complete exhibit of all articles manufactured by them at the Philadelphia National Export Exposition.

A. A. McCREARY, New York City, announces that his business in McCreary's electrical specialties has been taken over by the A. A. McCreary Company, incorporated, which has been formed for the purpose of increasing the facilities for handling the growing business.

MR. J. G. POMEROY advises that he has withdrawn from the firm of McGill, Pomeroy & Co., 317 Dearborn Street, Chicago. Mr. Pomeroy will give the larger portion of his time henceforth to the representation of the Adams Bagnall Company, of Cleveland, in the northwestern territory.

MORSE, WILLIAMS & COMPANY, Philadelphia, have recently finished the installation of three electric passenger elevators and one electric dumb waiter in the National Export Exposition in Philadelphia. The outfit is equipped with all the latest appliances and is in itself an interesting exhibit.

THE CL..G-SURFACE MANUFACTURING COMPANY, Buffalo, N. Y., reports that it has recently established a branch in Johannesburg, South Africa, to meet the increased demand for Cling-Surface in that section from those who have been compelled to run their belts as tight as possible to prevent slipping.

FREIGHTAGE TO THE PARIS EXPOSITION.—Jospeh C. Mount, General Shippng Agent and Freight Contractor, of 4 Lime Street, London, E. C., has made special arrangements for the conveyance of exhibits to and from the Paris exhibition of 1900. He is represented in America by Messrs. Sire Brothers, New York City.

THE PHILADELPHIA MACHINE SCREW WORKS, Philadelphia, reports that its business was never better than at the present time. It is exceedingly busy with general screw and electrical work and owing to the fact that it has recently largely increased its plant, it is better enabled now to fill orders promptly than heretofore.

THE BADT-GOLTZ ENGINEERING COMPANY, Chicago, is the new name of what was formerly known as the firm of Meysenburg & Badt, Mr. Edward A. Meysenburg having retired from the active management and the name of Mr. Wm. Goltz, secretary of the company, having been incorporated in the company's name.

THE NATIONAL ELECTRIC COMPANY, of Milford, Conn., has received a unique order from England. The order is for 50 complete sets of electric bells and fire alarm boxes for Windsor Castle. The company reports that it has received contracts for apparatus for several other almost equally famous structures in England.

THE STILWELL-BIERCE & SMITH-VAILE COMPANY, Dayton, Ohio, has established a branch office for St. Louis and contiguous territory in the Burlington Building in that city. The company will carry at this branch a full line of standard sizes of steam pumps, automatic feed pumps and receivers, air compressors and heaters, which will insure prompt deliveries.

THE HOLMES FIBRE-GRAPHITE MANUFACTURING COMPANY announces that it has secured new quarters in order to accommodate its increasing business, in Germantown, Philadelphia. At the new location modern machinery has been introduced to manufacture the product, fibre-graphite, which will enable the company to turn out this material in greatly increased quantities.

THE GEO. C. TOWLE MANUFACTURING COMPANY, Lancaster, Pa., is at present installing an additional 50 h. p. engine and boiler to meet the requirements of its ever increasing business. It is making a specialty of designing special motors to be direct connected to machinery, and reports having just received a large order for fans to be exported to South America.

THE KELLOGG SWITCHBOARD & SUPPLY COMPANY has moved its factory and offices into new quarters on the corner of Congress and Green Streets in the city of Chicago. The new quarters contain three floors, each about 175 ft. x 35 ft. in size, and give much more room for the work of the company than did the works at Highland Park, which will soon be discontinued.

THE NATIONAL WATER TUBE BOILER COMPANY, New Brunswick, N. J., has recently changed hands and come into the possession of a number of local business men whose purpose it is to again bring the National boiler into active competition with other makes. Mr. C. A. Schenck, who has been with the company for several years, is secretary and manager of the new concern.

THE ROSSITER-MACGOVERN COMPANY has been incorporated under the laws of New Jersey, with a capital stock of $250,000, and headquarters at Newark. The stated objects of the concern, whose principles are well known in the electrical field, are to build power houses, construct electric railways, etc. The incorporators are Frank Macgovern, Van Wyck Rossiter and Isaac M. Sutton

THE MANHATTAN GENERAL CONSTRUCTION COMPANY, manufacturer of the well-known Manhattan enclosed arc lamps, has removed to its new factory at Plane and Orange Streets, Newark, N. J., where its general offices are also located. The Manhattan Company, however, retains a sales office at its old address, No. 11 Broadway, Bowling Green Building, New York City.

THE CHICAGO DYNAMO & MOTOR CO., Chicago, is making a specialty of small dynamos for incandescent lighting, especially in units of 120 to 150 lights and also of motors from ¼ horse power to 15 horse power. This company claims to have met with a gratifying success on its one horse power motor, which is made especially for wholesale grocery houses, to be used on coffee grinding mills.

THE AMERICAN ENGINE COMPANY, Bound Brook, N. J., furnished the engine, generator and motors for the electrical equipment of the power and machinery department of the World's Dispensary Medical Association of Buffalo. The plant is quite an extensive one, consisting of an American Ball compound engine direct-connected to a generator with both belted and direct-connected motors.

THE STAR ELECTRIC COMPANY, Binghamton, N. Y., reports business very brisk in all lines, and an increasing demand for its annunciators and other specialties, besides a large sale for Emerson fans, Anchor specialties and porcelain goods which it is pushing extensively. The company also mentions that it is at this time in position to quote particularly interesting prices on porcelain insulators, tubes and cleats.

THE GENERAL INCANDESCENT LAMP COMPANY, Cleveland, Ohio, has succeeded

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to the business of the Fort Wayne Lamp Company, having purchased the assets of the old concern. The new company is closely associated with the other company, the name of which it so nearly follows, viz., The General Incandescent Arc Light Company of New York City; the president of the lamp company being Mr. Samuel Insull.

THE VULCANIZED FIBRE COMPANY, Wilmington, Delaware, finds that its business has grown to such an extent that it has been compelled to add to its already large works. The new building will be a three-story brick addition to the old factory and will be 135 x 30 ft. in size.

THE BOARD OF DIRECTORS OF THE CUTTER COMPANY, Philadelphia, tendered Mr. Henry B. Cutter, president of the company, an informal dinner on the occasion of his recent return from abroad. Mr. Cutter gave an interesting resume of his trip, describing some of the important electrical establishments which he had visited. He expressed himself as gratified at the popularity of the Cutter Company's apparatus abroad.

THE INTERNATIONAL CORRESPONDENCE SCHOOLS, Scranton, Pa., made quite an event of the annual convention of the National Association of Letter Carriers. In honor of the occasion the schools had a large monogram I. C. S. with letters of incandescent lamps in front of their building. As this institution has such an enormous amount of mail the carriers from all parts of the country are interested in inspecting the home office.

THE WATERTOWN ENGINE COMPANY, Watertown, N. Y., has opened an office in Chicago at No. 900 Fisher Building, in charge of Mr. F. H. Pond. Among recent sales they report one of their new vertical direct connected high-speed engines to the Deering Harvester Company, and three vertical cross compound condensing engines to the Pennsylvania R. R. for their Ft. Wayne shops; also two 7x7 vertical engines direct connected to Westinghouse generators.

THE MICHIGAN ELECTRIC COMPANY, Detroit, Michigan, has undertaken a rather unusual piece of work in the complete equipment of a yacht with a gasolene engine driving a generator with storage battery, searchlight and complete fixtures. The same craft will be fitted by the same company with an electric revolution indicator and an engineer's signal system, giving it altogether one of the most complete electric plants ever designed for a yacht.

THOMAS J. JOHNSTON has opened an office in the Park Row building, New York, for the practice of law, his special province being the conduct of patent cases, either in the courts or the United States Patent Office. Mr. Johnston was admitted to the bar 17 years ago, and for six years past he has been retained by the General Electric Company in its patent department as an assistant to Frederick P. Fish, the well-known patent counsel. He has a wide acquaintance among electrical men.

THE MANHATTAN GENERAL CONSTRUCTION COMPANY has, since its purchase by Mr. Geo. Westinghouse, removed its general offices to the new location of its works at Newark, N. J. The company reports that its new direct-current lamps are giving service which has brought in many orders, two dry goods stores in the Northwest having ordered respectively 87 and 142 lamps, another order of 60 lamps having been obtained from the American Bridge Works, Chicago.

THE JEWELL ELECTRICAL INSTRUMENT COMPANY, Chicago, has been organized to take over sales of the electrical instruments formerly sold under the name of the McIntosh Battery & Optical Company. Mr. Edward W. Jewell is president of the new concern and Mr. Geo. M. Willis is general sales manager. These instruments will be manufactured as heretofore by the McIntosh Battery & Optical Company and under Mr. Edward W. Jewell's personal supervision.

THE A. B. PITKIN MACHINERY COMPANY, Providence, R. I., announces that it has recently acquired the records, drawings, patents and parts, finished and unfinished, of Armington & Sim's engines, and is completing arrangements which will enable it to fill orders for repairs or the renewal of parts of the large number of engines of this type in use. The company also lists a number of second-hand engines and boilers which it has for sale in addition to new engines and boilers of all powers.

THE H. W. JOHNS MANUFACTURING COMPANY, New York City, will make at the Street Railway Convention an extensive exhibit of its line of molded mica overhead insulation, its car heaters and its "Noark" indicating fuses for 500-volt circuits. The fuses will be shown in operation, the company promising something in this line ahead of anything previously exhibited. The exhibit will be in charge of the company's Western representatives, the Manville Covering Company, Chicago.

BAUGHER, KURTZ & COMPANY, LTD., is the name of the re-organized firm of York, Pa., formerly known as Baugher, Kurtz & Stewart, manufacturers of heavy iron and brass work and notably of turbine water wheels. Mr. W. F. Bay Stewart has retired and Mr. Geo. U. Wiser has joined the company and become the treasurer. The company is adding to its works a new shop to handle the large amount of business offered. Among recent shipments was one of a large turbine wheel to Barcelona, Spain.

WESTINGHOUSE, CHURCH, KERR & COMPANY have recently closed the greatest sale of gas engines as yet recorded. Twelve engines were ordered, aggregating 3000 h. p., for a cement factory in Kansas, the total price being $91,000. The company has also closed some large contracts for complete traction installations, one notable one being that of the Toledo, Fremont & Norwalk Electric Railway, which will run a distance of 60 miles with one central power plant generating high tension three-phase currents, and seven rotary sub-stations.

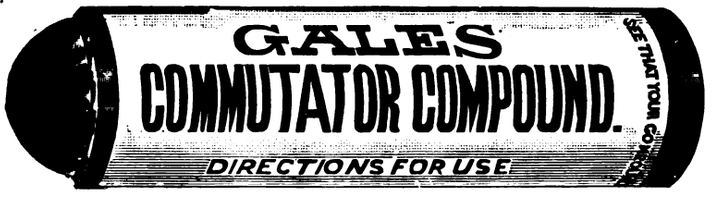
THE MICHIGAN ELECTRIC COMPANY, Detroit, Michigan, carried out the entire work on the special illuminating feature of the Elk's Carnival, held in Detroit, August 21st to Sept. 2d. Something over 2000 incandescent lamps were used on arches and other decorations. The lamps were entirely in color, the lightest being amber colored, which were centered around the entrances of the arches, the deeper-hued lamps forming a framework about them. The special illuminating effects were carried out in accordance with the ideas of Mr. Jos. E. Lockwood, president of the company.

THE MORRIS ARC LAMP COMPANY, Chester, Pa., has brought out a folder illustrating and describing its perfected "1900" Morris enclosed arc lamps. This is an improved form of the lamp described in the American Electrician of last May, the casing being adapted to outdoor use. The regulating mechanism of this lamp consists of a concentric solenoid operating a "tilting ring" clutch working on the carbon itself, the current being introduced to the carbon through fine copper brushes secured to the upper carbon holder and bearing with an easy pressure upon the interior walls of the carbon tube.

THE FALCON ELECTRIC MANUFACTURING COMPANY, New York City, is a newcomer in the electrical field, which intends manufacturing a complete line of switches and switchboards as well as a general line of electrical specialties. Mr. H. O. Swoboda, an engineer well known in his own line, who has been for the past seven years identified with the General Incandescent Arc Light Company, will have charge of the factory as general manager and superintendent. The officers of the company are Mr. Edward Leissner, President; H. O. Swoboda, Vice-President, and L. E. Frorup, Secretary and Treasurer.

CHICAGO RHEOSTAT COMPANY.—While the Chicago Rheostat Company has removed from Chicago to New York, branch offices with a large and well assorted stock of rheostats will be maintained at 1012-1013 Monadnock Block, Chicago, to accommodate a well developed Western business, but


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the factory and main office will be in New York, in charge of Mr. E. W. Hammer, at 397 to 407 East 33d Street. While the growth of this company has shown a splendid increase, it is believed that the domestic business can be handled as well from New York with a decided advantage in the handling of foreign trade.

THE DETROIT LUBRICATOR COMPANY, Detroit, Mich., has, for purposes of record and identification, numbered its sight feed lubricators consecutively from No. 1 upwards, so that the number appearing on a lubricator shows how many had been manufactured up to its time. On Sept. 15, 1899, the company reports that it had completed lubricator No. 460,000. When it is considered that as a rule only one lubricator is used on an engine this figure gives eloquent testimony to the general use of the Detroit lubricators in this and other countries. The company's present output of sight feed lubricators alone amounts to over 5,500 per month, and it also reports a rapidly growing trade in the new style glass oilers and oil pumps.

THE HANSON VAN WINKLE COMPANY, Newark, N. J., is developing a new field for the use of its electro-plating machinery in the application of an electrolytic process for removing metal, constituting it the reverse of electro-plating. The metal to be removed is the spelter and brass around brazed joints, the greatest need for a process of this kind being in the jointing of bicycle frames. Methods heretofore used involved the treatment of such joints in an acid pickle, which is injurious to the steel parts as it is likely to leave a tendency to rusting. The electrolytic process is accomplished in a strictly alkaline solution, which is harmless to the tubing. The process leaves the metal bright and clean for enameling.

THE ANNUAL CLAMBAKE OF THE AMERICAN ELECTRICAL WORKS, Providence, R. I., was held on Saturday, Sept. 9th, at the Pomham Club near Providence, about 400 guests being present. The party met at the Narragansett Hotel and made the trip to the club in specially chartered trolley cars. The usual athletic sports were indulged in and were followed by the clambake dinner. The menu, following the style of the invitations, was printed on sheets of frosted copper. Major R. S. Brown of the Westinghouse Company served as toastmaster and addresses were made by Eugene F. Phillips of the company, Congressman A. B. Capron, President F. A. Gilbert of the Boston Electric Light Company and others. Each guest was presented with a handsome souvenir in the form of a miniature loving cup.

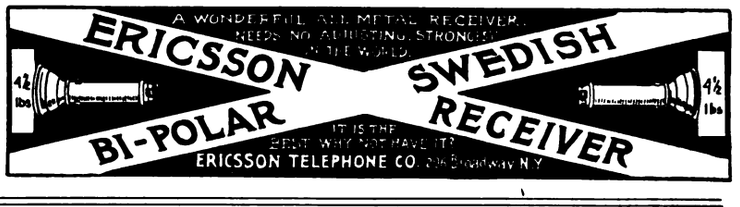
A STORAGE AIR BRAKE SYSTEM.—The value of air brakes on electric cars and the fact that such small train units hardly warrant the complexity of either an axle driven or motor driven compressor, has brought upon the market an air brake system in which the air is compressed by a stationary compressor at the power station or other convenient point and carried at a pressure of 300 lbs. in storage tanks upon the car, which are recharged at convenient times. The system is being introduced by the G. P. Magann Air Brake Company of Detroit, Michigan. The particular advantages are the simplicity and low first cost of the car equipment, the noiselessness of operation, the higher economy of a large stationary compressor, etc., which will be apparent on consideration of the fundamental principles of the system.

MR. GEORGE W. PATTERSON, the general Western agent of the American Circular Loom Company, has developed various specialties which go to make up a very interesting evening's entertainment, all accomplished with electrical devices. Mr. Patterson is an expert swinger of Indian clubs and these he illuminates with lamps of different colors controlled by an attendant behind the scenes, the clubs giving, when in rapid motion, very beautiful effects. Other features are an electrical storm, an electrically illuminated rainbow, a telephone with megaphone attachment and the various high tension effects than can be obtained with an electrolytic interrupter. Mr. Patterson desires to obtain a number of other interesting electrical devices to exhibit at these entertainments, and the manufacturers of such are requested to correspond with him at his office in the Marquette Building, Chicago, Ill.

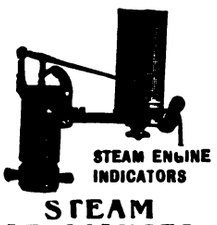
THE MICHIGAN ELECTRIC COMPANY, Detroit, Mich., has been successful in securing some important contracts and orders for parties it represents, these including a contract to J. G. White & Company of New York City from the Detroit, Rochester, Romeo & Lake Orion Railway for complete power house equipment, including two 250 h. p. B. & W. type Aultman & Taylor water tube boilers, two 300 h. p. Ball & Wood special design tandem compound engines, two 200 k. w. Crocker-Wheeler railway generators, one Crocker-Wheeler motor-driven booster, one Westinghouse 90 k. w. alternator, motor driven, a complete switchboard and complete equipment of condensers, pumps and all of the details required for a high grade power house. The company has also secured an order from the Toledo, Fremont & Norwalk Electric Railway for over 21,000 Atkinson protected rail bonds, this order being one of the largest ever placed in the country for similar goods.

THE AMERICAN ELECTRIC SPECIALTY COMPANY, New York City, is placing on the market an instrument designed to locate grounds or short circuits, particularly in telephone or other lead covered cables. The design and principle of the instrument are similar to those of the company's direct reading ohmmeter. The principle is that of the slide wire bridge, a fall of potential being established on the grounded or crossed conductor by connecting its two ends to a battery. The same battery is connected to an exposed resistance wire of the instrument placed over a graduated scale. The telephone, which is used in place of a galvanometer, is then connected between the ground and a conducting point, which can be tapped upon this resistance wire. When the telephone is silent the point under the tapper has the same potential as the ground, and therefore the drops of potential to either side of the point are to each other as the drops in the cable tested to either side of the ground. The scale reading thus gives the ratio of the distance of the ground to the length of the cable.


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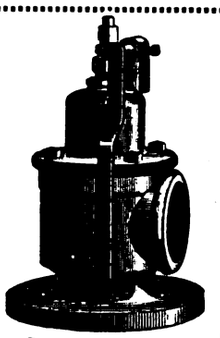






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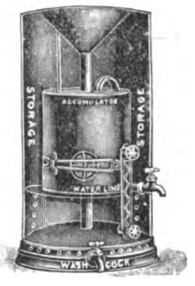
COLOR UNDER ARTIFICIAL LIGHT.—A prominent American artist, who has made a great many experiments in lighting paintings with incandescent light, claims that it is not alone the quality of the light, but to a certain extent its quantity, that affects the color values. This is explainable on the score that the artificial light is weak in some colors and must, as a whole, be strengthened in order to give sufficient intensity to those shades to make them prominent. Yellows, for instance, which under ordinary gas or incandescent light are almost white, retain their true value under a strong and evenly diffused light. This theory is substantiated by the experience of I. P. Frink, New York City, in lighting paintings in the large art galleries, and his application of the same principles to store window lighting gives merchants practically the daylight colors of their goods at night. This is especially important to dry goods houses, for their windows are filled with daintily colored dress fabrics, which attract attention primarily by their colors. Frink's patent window reflector gives a very strong and evenly diffused light, yet no lamp is in view to distract the eye by its concentrated brilliancy; and under this light color values hold their own in a way that is surprising.

THE ELECTRIC SIGNAL AND BURGLAR ALARM CLOCK is the name of a piece of apparatus which on first presentation conveys the idea that the designer had assumed that burglars might be expected at a certain definite hour and had utilized an alarm clock for forestalling them. The clock is simply a good time piece, designed to run thirty days without rewinding and fitted with time contacts and a plug board such that any bell wired to it may be rung at any predetermined time. It is thus a great convenience in hotels for awakening guests and announcing trains, in stores and factories for announcing the time of taking up and leaving work without giving a general alarm, and even in private houses for use as an alarm clock and announcing the time for the various domestic duties of the day. The burglar alarm feature of the clock is simply a switchboard by means of which any or all of the various bells wired to it may be connected with the burglar alarm circuit. The same switchboard allows any push button to be transferred at any time to any bell, the clock thus serving as a sort of central exchange for making up any desired push button and bell circuit. The apparatus is made by the Electric Signal Clock Company, Galion, Ohio, for which the Central Electric Company, Chicago, is the Western sales agent.

THE AMERICAN STEEL & WIRE COMPANY'S ELECTRICAL PRODUCTS.—The recent financial changes in the iron and steel manufacturing industries have been so numerous and kaleidoscopic that many users of the products of the companies in this line of work have not become familiar with the new status of the manufacturing houses. Contrary to the assumption which might be created by its name, the work of the American Steel & Wire Company is by no means confined to the production of iron and steel wires or their products. By the absorption of the Washburn & Moen Manufacturing Company the larger organization inherited one of the world's most important manufactories of bare and insulated copper wires for all electrical purposes. With the immense plant at Waukegan, Ill., only 35 miles north of Chicago, at which much of the copper wire is produced, the American company enjoys exceptional facilities for catering to the wants of the trade in the West, giving as it does the same prestige in the western field that is enjoyed by the Washburn-Moen department at Worcester, Mass., in Eastern territory. The merging of this company into the American Steel and Wire Company means simply a further step in the progress whereby with unlimited resources, continued investigation and improvements a still greater superiority is assured in the production of all forms of electrical wires, rail bonds, etc. At the Waukegan plant special attention is given to the manufacture of the well-known "Extra BB," "BB," and "Steel" telephone and telegraph wires and copper wires for electric lighting and street railway plants in all their various forms. The company also has extended its facilities at Worester for the manufacture of its various types of rail bonds and its complete line of insulated wires. The general offices of the company are located in "The Rookery," Chicago, with branch offices in New York, Worcester, St. Paul, St. Louis, Cleveland, Denver, San Francisco and other cities.

## THE BEST SHOOTING.

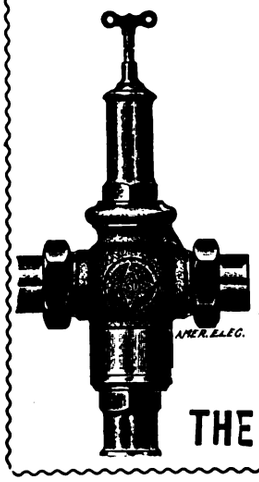
The shooting in Iowa, Minnesota and South Dakota this year promises to be very good as the rainfall in all these states was abundant. The best localities for chicken and duck shooting are on and tributary to the lines of the Chicago, Milwaukee & St. Paul Railway. A copy of a recent publication issued by the passenger department of that road can be had on application to Geo. H. Heafford, General Passenger Agent, Chicago, Ill., and enclosing three cents in stamps for postage.


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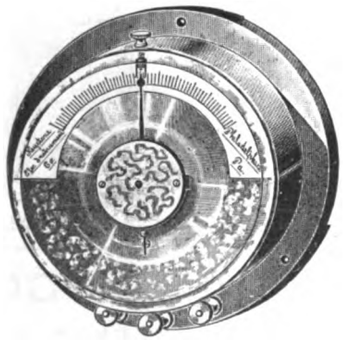
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# American Electrician.

Vol. XI. New York, November, 1899. No. 11.

## THE ELECTRICAL EQUIPMENT OF THE LARGEST SHIP AFLOAT.

### A Description of the Electric Lighting, Electric Motor and Telephone Systems on the Steamship "Oceanic."

By far the largest ship afloat, or now building, is the "Oceanic" of the White Star Line, which made her first voyage to this side during the month of September, 1899. The electrical equipment of this ship is of interest from its connection with this prodigy of marine architecture alone, and in this case there is added interest in this country due to the fact that the apparatus is of foreign design and construction, and exhibits many features differing from American practice. The following description will aim to bring out some of these interesting peculiarities, which may serve in the way of suggestions to those designing marine equipments in this country.

But little need be said of the ship in general, so widespread has been the discussion of her main points in the public press. With a length over all of 704 feet, 12 feet more than that of the "Great Eastern," a displacement of 30,000 tons at 32 feet draft, and a capacity for 17,000 tons of cargo and 410 first class, 300 second class and 1000 third class passengers, she by far outclasses, in point of magnitude, all previously built ships. Her main driving equipment is not designed to give her the great speed that might be obtained with a ship of this size. Indeed, it has no greater power (28,000 h. p.) than that of some smaller craft, but it is intended to bring her into port on the seventh

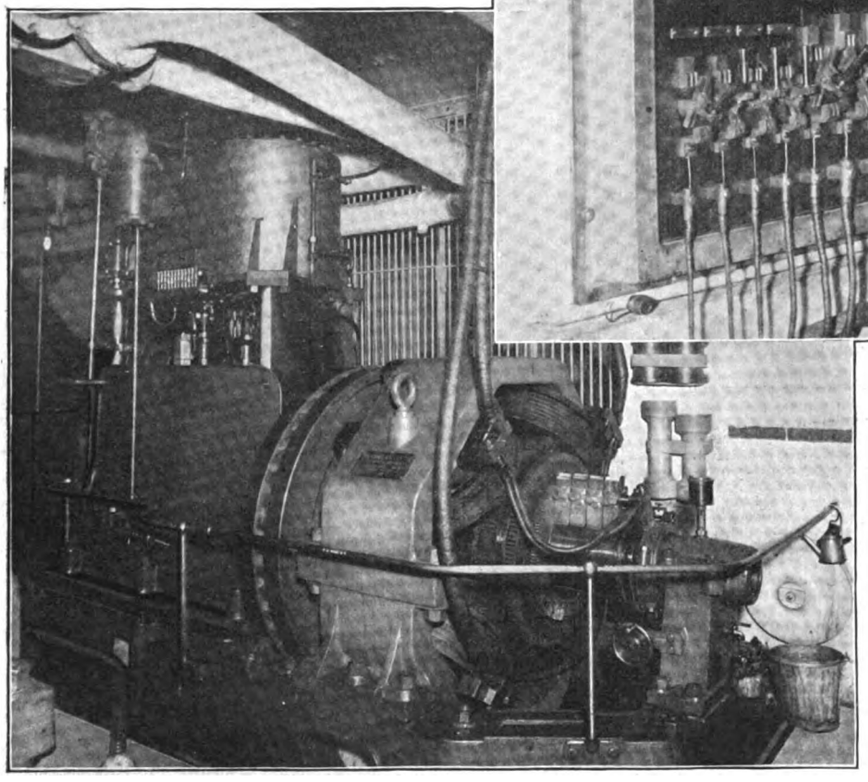


FIG. 1.—ONE OF THE GENERATING UNITS OF THE "OCEANIC."

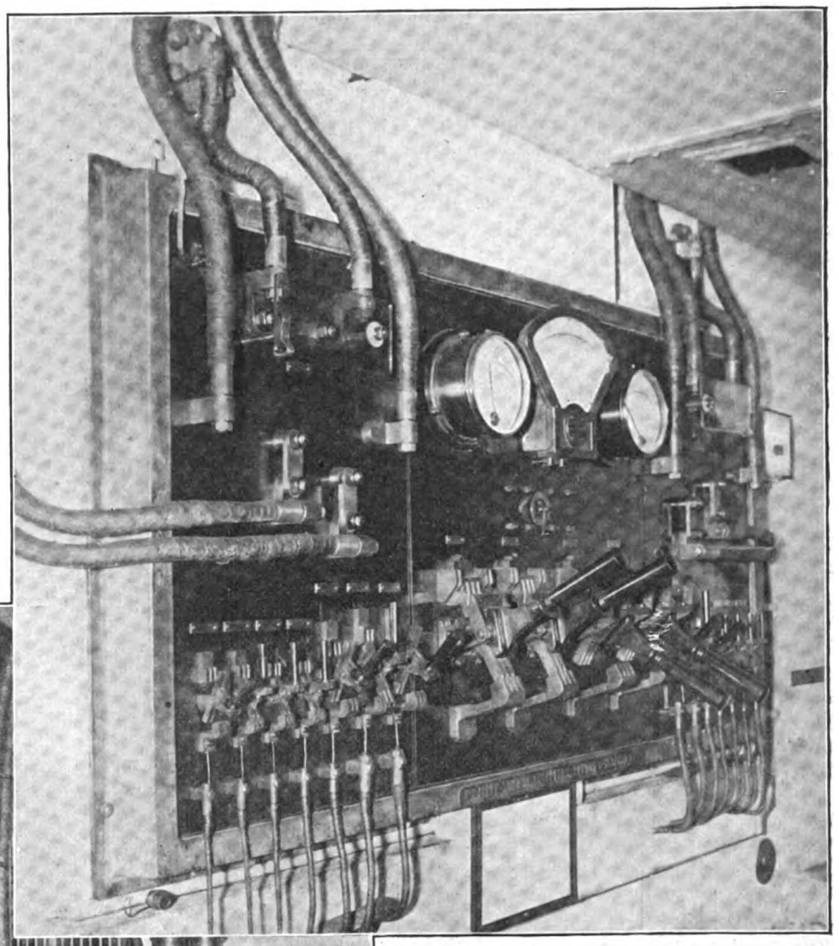


FIG. 2.—ONE OF THE SWITCHBOARDS, SHOWING THE GROUNDING PLATES ON THE BULKHEAD OVER IT.

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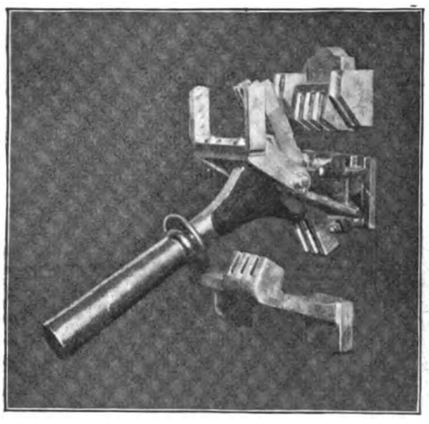


FIG 3.—ONE OF THE MAIN SWITCHES.

morning from her date of sailing with schedule regularity.

The electrical generating plant consists of four direct-coupled machines, which are mounted aft of the main engines and on the intermediate platform, at an elevation a few feet below the lower cylinder heads of the main engines. This location is far superior to that often adopted, viz., lower down in the ship and between the main shafts, since it is above the water line, lighter, more airy and less cramped. The four machines are arranged with fore and aft shafts in two pairs, one to either side of the longitudinal water-tight bulkhead which divides the port from the starboard engine room. Each unit consists of one cross-compound vertical engine of a very simple character, the two cranks being set 180° apart so that the two piston valves, one for each cylinder, can be driven by a short crosshead, operated by one simple eccentric between the cranks.

Contrary to all American practice, but in conformity with English custom, the speed control is accomplished by a throttle, which is in this instance driven by a shaft governor. The dynamos have no field rheostats whatever, so that the adjustment of the voltage and the division of the load when running in parallel must be accomplished by varying the speed. This is provided for by means of a spring connected to the linkage by which the shaft governor operates the throttle valve. The tension of this spring, which helps to balance the centrifugal force of the governor weights, can be adjusted by means of a screw and hand wheel, thereby varying the speed at which the governor will open or close the throttle valve. This mechanism is shown in Fig. 4.

The engines take their steam from the main boilers through a reducing valve which drops the pressure to 100 pounds per square inch, and exhaust, when at sea, into the main condensers, and when in port into the auxiliary condenser. A peculiarity of the main engines of the "Oceanic" is the fact that no cylinder oil is used and consequently no filters are used for removing the accumulations of oil from the feed water returning from the hot well to the boilers; a practice differing from that customary in other ships. On this account the use of cylinder oil is not permitted in the engines driving the dynamos and it has been found that under this condition the governing throttle valves, which are of the balanced piston type, with no packing rings, bind so that the governors cannot control the speed. For this reason the control of the voltage and the division of the load are adjusted by hand operation of the stop valves of the engines, the load being sufficiently constant to permit this rather primitive method of operation.

Each engine is direct coupled to a 60-kw. four-pole generator, the general design of which can be seen in Fig. 1. These machines differ from American dynamos in several features. They are compound-wound, the series turns being put on two opposite poles only and over

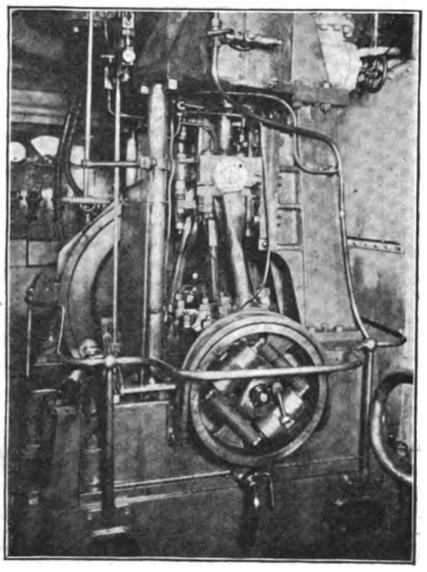


FIG. 4.—AN END VIEW OF ONE OF THE ENGINES SHOWING THE GOVERNOR AND ITS CONNECTION TO THE THROTTLE.

the shunt coils, the two other poles being wound only with the latter. The extension of the lower casting of the machine, which runs out to the bearing at the commutator end, is slotted, and to this slot there can be bolted a tool holder with longitudinal and cross feeds, for turning down the commutator at any time. The armature windings have spiral end connections, the coils being series connected, and each machine has only two brush holders instead of the four which might be used on four-pole machines.

One of the most interesting parts of the equipment is the pair of switchboards, one in each engine room, a view of one of which appears in Fig. 2. The central and main instrument on each board is a voltmeter with scale reading only from 80 to 120 volts; the normal voltage of supply at which the lamps are rated being exactly 100 volts. Flanking the voltmeter on each side is an ammeter, one for each generator, beside which may be seen the main fuses, under glass covers, the lower part of the board being occupied by the main and feeder switches. The general scheme of the board may be described as follows:

There are two sets of bus bars, one for the lighting circuits and one for the power circuits, there being two bus bars in each set, one positive and one equalizer, there being no negative bus bar whatever on the boards. This is due to the fact that the hull of the ship is depended upon for a return circuit on the negative side of the system. The negative lead of each dynamo is carried to the switchboard and there through an ammeter and single-pole fuse, from which a cable two or three feet long leads off above the board to a circular contact plate about nine inches in diameter, bolted directly to the bulkhead, against which the switchboard is set. It is notable that there is no space behind the switchboard to get at bus bars or other connections, the board being fixed close to the bulkhead, all cables leaving from the front so that the necessity of getting behind the board is removed.

The main switches are of a peculiar type, shown in detail in Fig. 3. The main circuit on the positive side is carried through a vertical piece in the center of the switch fitted with multiple knives on each end designed to engage suitable jaws. This piece is rotated on a horizontal pivot at its center by means of a toggle action operated by the handle. On the upper part of the movable part of the switch is a U-shaped contact which closes the equalizer circuit. There are two such switches for each generator, one connecting with the power and the other with the light bus bars, instead of the double-throw switch which would be used

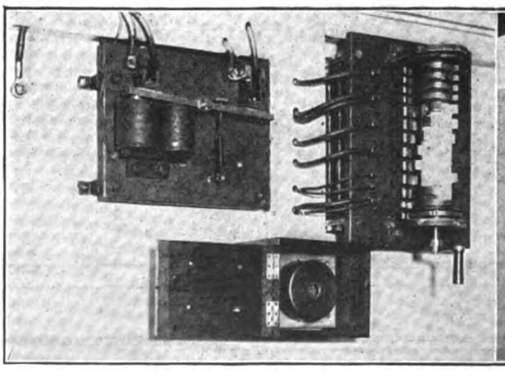


FIG. 5.—THE CONTROLLER, SWITCH AND MAGNETIC BRAKE SWITCH OF THE PROVISION HOIST.

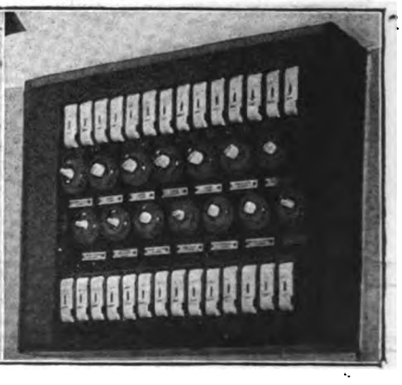


FIG. 6.—ONE OF THE DISTRIBUTING PANELS.

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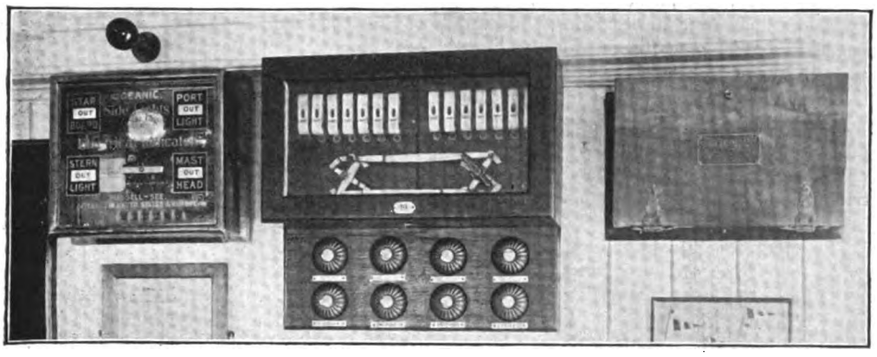



FIG. 7.—A VIEW IN THE WHEEL-HOUSE SHOWING THE SIGNAL INDICATOR, THE SIGNAL LIGHT AND TELEGRAPH CIRCUIT PANEL WITH ITS THROW-OVER SWITCH FROM A PORT TO A STARBOARD FEEDER, AND THE CASE CONTAINING THE AUTOMATIC WHISTLE APPARATUS.

in this country. On this account a bus-junction switch is unnecessary. The parallel working of the two switchboards, however, requires bus-junction cables, four in number, for the power and light equalizer and positive buses. The ends of these four cables entering the front of the board, two on each side, may be plainly seen in the illustration of the board, Fig. 2. The cables terminate in links by which they may be disconnected in case it is desired to dismantle one switchboard while the other is in operation.

All the feeder switches are, of course, single-pole, since the wiring throughout the ship is purely single-pole, every lamp, motor or other current-consuming device being connected directly to the ship's plating for a return circuit. The feeder switches are, as the illustration shows, of the same type as the main switches, but on a smaller scale. Immediately below them are the fuses and the name plate over each switch specifies not only the cross section of the copper in that feeder but the proper size of fuse. The fuses are of tinned copper cables, made up in all cases of wire No. 33 English standard wire gage, different capacities being obtained by varying the number of strands in the cable or the number of cables between the fuse terminals. For instance, one plate specifies 5 strands, another 9, another 20 and still another 40. Circuits requiring more current than can be supplied by a 40-strand cable have two or more cables in parallel. Similarly the main fuses are specified on their accompanying name plates, each fuse consisting of two strips of tinned copper, each 1 inch x .013 inch in cross section (the rated current of each dynamo being 600 amperes), the two strips laid together between the bolted contacts. The switchboard attendant is protected from the violent blowing of the main fuse by a heavy cover of plate glass placed over it and swiveled so that it can be readily turned back.

The load carried by this generating plant consists of some 2000 incandescent lights, a dozen motors driving ventilating fans and some 200 electric heaters in the first-cabin state rooms, besides various electric cooking devices, such as grills in the kitchens, water heaters in the bath rooms and numerous small motors scattered about for operating such loads as a provision hoist, the spits in a roasting oven, a power-driven rotary hairbrush in the barber shop and other minor apparatus. Some of the special applications of the current call for apparatus of American manufacture. The controller of the motor-driven winch of the provision hoist, shown in Fig. 5, was made by the Crocker-Wheeler Electric Company and the electric heaters scattered throughout the state rooms are those of the American Electric Heating Corporation.

The current is carried throughout the ship in what are known abroad as lead-covered and armor-clad cables, the term armor-clad signifying a wrapping of steel wire similar to that used on submarine cables. This does away with the necessity of either molding or iron-armored conduits, making the installation of the wiring a comparatively simple and cheap undertaking.

The main feeders run to branch boxes like that shown in Fig. 6, containing snap switches and porcelain removable fuse holders from which single-conductor branch cables run from lamp to lamp, the socket shell of each lamp, which forms one contact with the base, being grounded by its support upon the plating or framing of the ship.

The telephonic equipment of the vessel is of the heavy, substantial type adopted in the British Navy. On the bridge immediately forward of the wheel house and protected from the weather by a roof and front wall are the engine-room telegraphs and four telephone instruments. A view of two of these, mounted between the windows of the wheel house, is shown in Fig. 8. The instrument proper consists of a heavy, cast-iron box with two openings, normally closed by a rotating cover. By moving this to the open position the proper connections of a microphone and telephone receiver are made. The upper opening communicates with the receiver and the lower with the transmitter. One of these four instruments communicates with each engine room, one with the after docking bridge and the other can be connected by means of the switch shown just below it in the illustration to either

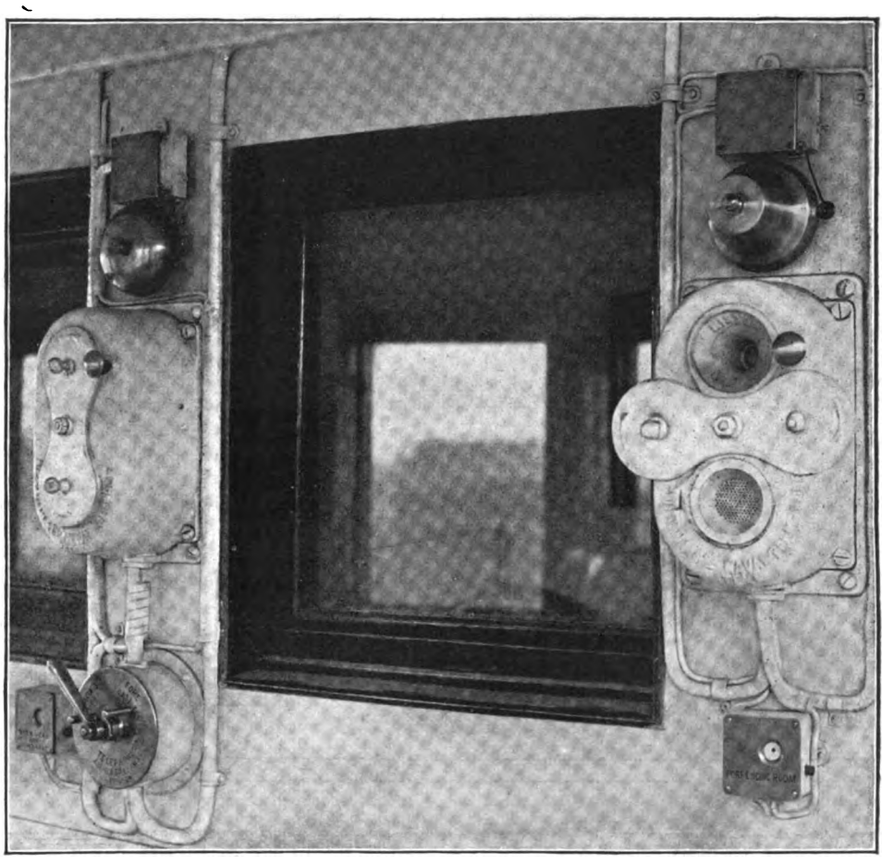


FIG. 8.—TWO TELEPHONES ON THE BRIDGE, ONE CLOSED AND ONE OPENED.

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the forecastle head or the crow's nest, these two points being so far distant from the bridge on this mammoth ship that telephonic connection with them is necessary. The same illustration shows the operating handle of the electrically controlled whistle which also is fitted with the American made apparatus of the Signal & Control Company of Brooklyn for blowing the whistle either by hand or automatically at prouer intervals in case of fog.

Within the wheel house is still another piece of American apparatus, viz.: the Russell-See electric indicator (made by the Wm. Porter's Sons Company) for giving visible and audible warning in case any one of four main lights is extinguished, these four lights being the starboard and port side lights and the stern and masthead lights.

The electrical equipment of the ship was built by W. H. Allen, Son & Co., London and Bedford, England, and is in charge of Mr. R. J. Thomas, chief electrician, to whom thanks are due for the information given above.

The most forcible impression conveyed by an inspection of the steamship "Oceanic" is one of solidity, reliability and durability, features that characterize her electrical equipment, as well as her construction throughout.

# An Electric Railway in Central America.

BY DAN WELLS CASEMENT.

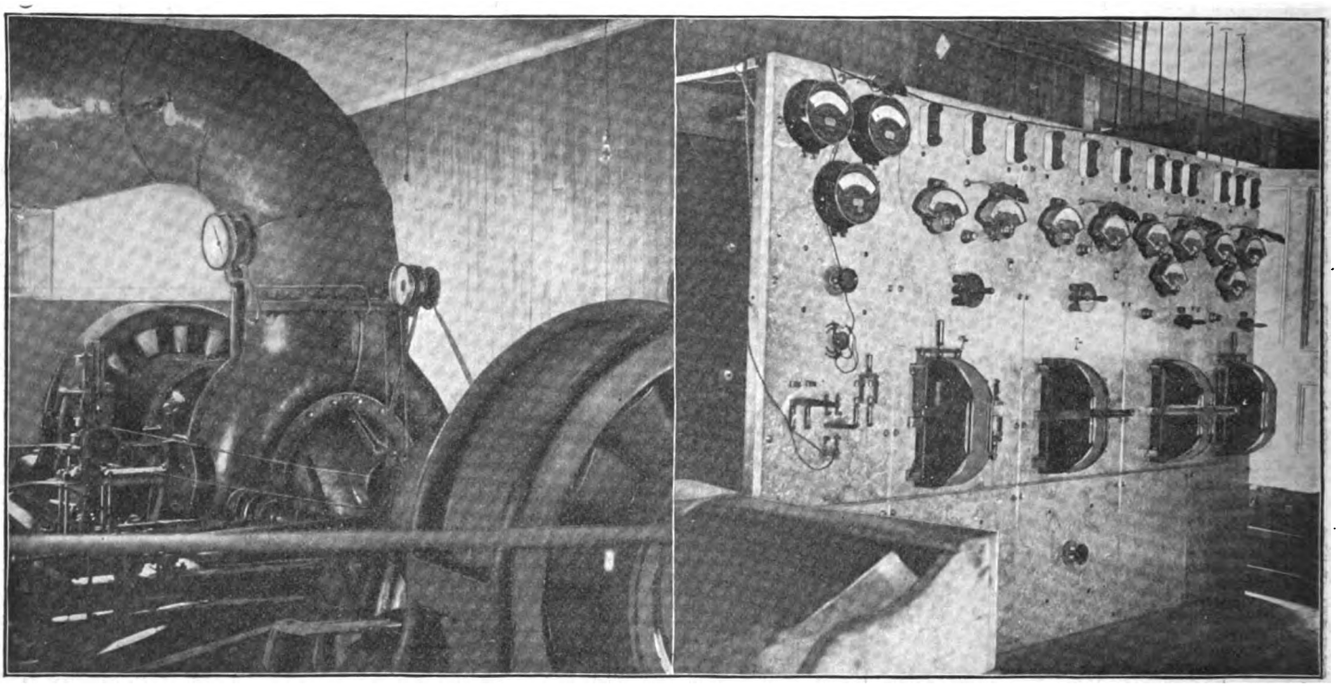
In San José, Costa Rica, during the month of April, 1899, the first electric railroad in Central America was opened for regular service. San José, a city of about thirty thousand inhabitants, is the capital of Costa Rica, and one of the most progressive cities in Central America. There is an abundance of water power throughout the whole of Costa Rica and for a number of years the principal cities have had electric lights, both arc and incandescent, the current being generated by water power.

Within the last year the Costa Rica Electric Light and Traction Company, Limited, has taken in the three plants at San José besides one in Cartago, and has replaced many of the old machines and instruments and added machinery of suitable capacity to operate the railway. The tramway is, at present, about three miles long, but will probably soon be extended to one or two of the suburban towns. There are four cars, each equipped with two G. E. 58 motors, controllers and electric brakes. The grades are quite heavy, maximum 7 per cent., and the cars, especially on Sundays, are generally heavily loaded, but as yet not a single motor has been burnt out.

When taken hold of by the Costa Rica Electric Light and Traction Company, Limited, the following three plants were in operation in San José: the Anonas plant, about three miles from the city, which contained two 55-kw. Westinghouse single-phase alternators supplying part of the incandescent light, and one Wood 100-light arc machine, supplying part of the street lights; the Rio Torres plant, situated on a river at the north end of the city, with one General Electric 75-kw. 2200-volt monocyclic alternator, supplying the remaining incandescent lights and an arc light plant at the east end of the city with two T. H. arc machines which supplied the remaining street lights.

The new company has enlarged the Anonas plant and made of it the principal station which now supplies power for the tramway and a large portion of the incandescent and arc lights. The old water power at this plant was no more than sufficient to operate the old equipment so it was necessary to use another stream, which is considerably larger than the old one but its head is only 90 ft., while the head of the old power is 180 ft. The old stream, The Maria Aguilar, is brought to the power house through a 36-in. flume, 500 ft. in length, and has an estimated capacity of 270 h.p. The water from the Rio Tiribi is carried through a long ditch to a small reservoir and thence to the turbine through a 56-in. pipe, 500 ft. long.

The two Westinghouse alternators have been removed, the building has been lengthened and a 450-h.p. turbine on one shaft with two 300-kw. three-phase General Electric generators has been installed. The turbine was built by the James Leffel Company and is controlled by a Lombard water wheel governor. The generators are coupled to the turbine by means of Hill friction clutches, and either is large enough to operate the tramway and the incandescent lights at the same time. The 75-kw. three-phase generator, originally at the Torres plant, but now direct belted to one of the old Pelton wheels at Anonas, takes care of the incandescent load after midnight when the tramway is shut down and but a small portion of the lights are in circuit. A new No. 9 Brush arc dynamo of 125 lights capacity, 1200 c.p. each,



THE TURBINE, GENERATORS AND SWITCHBOARD OF THE ANONAS PLANT.

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has been installed at this plant in place of the Wood machine which has been removed to the Torres station and is held in reserve. The switchboard of blue Vermont marble is made up of six panels, three machine panels, two feeder and one exciter panel. The two feeder panels are for the tramway and incandescent light service, respectively. One panel controls the two exciters; these are of 12½ kw. each, one being belted to the main turbine and the other to the double Pelton wheel which drives the 75-kw. alternator. With this switchboard any possible combination between machines and lines can be made. The arc machine is also provided with a plug board for controlling the arc light circuits.

The three-phase current from the Anonas plant is transmitted to the Rio Torres Station at 2200 volts by three No. 1 mains, where it is led without transformation direct through the switchboard to the synchronous motors of the motor-generator sets. Each of these sets is made up of a three-phase synchronous motor of 100 kw. direct-connected to an 85-kw. direct-current generator on the same base. This generator furnishes direct current to the railway at 550 volts and also excites the synchronous motor. The switchboard at this station is at present a five-panel board. The railway generator panels are of the customary type with a large Weston station voltmeter swung to the side, and each is provided with a magnetic blow-out circuit breaker at the top of the panel. The synchronous motor panels are similar to the machine panels at the main plant, being equipped with Thomson alternating voltmeter and three ammeters, quick break main switch, fuses, field rheostat and exciter switch. The fifth panel is one on which is mounted a synchronizing device and a special switch for starting either of the motor-generator sets from the direct-current side when the other is already in operation. The Wood arc machine, now installed at this plant is direct belted to a double Pelton wheel designed to develop 50 h.p. under a head of 58 ft. The water for this wheel is taken from the Torres River, a considerable distance above the plant, and, like most of the water powers near San José, is used in the coffee curing establishments before reaching the reservoir from which the turbine is supplied.

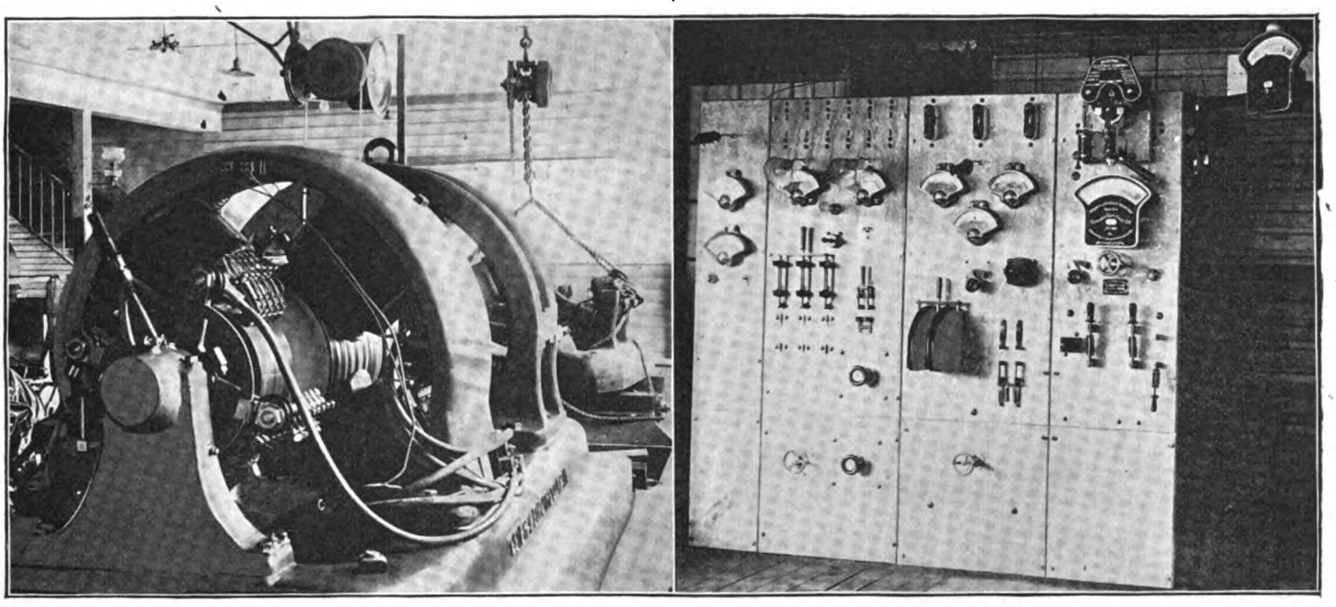
Over the machines in the illustration of the motor-generator on this page, there may be seen supported from the ceiling a special form of tachometer. This is belted to the shaft of the machine below it. Owing to the fact that the motor is of the synchronous type, this tachometer indicates a speed exactly proportional to that of the generators. It is provided with contacts wired to an alarm apparatus intended to give audible indication should the speed of the generators rise or fall to such an extent as to require the attention of the attendant to the machines in the sub-station.

The old arc lighting plant is not of sufficient interest to deserve description, except that it was the first plant in the country and has been in operation seven years. Originally, this plant contained two Thomson-Houston dynamos, one of 50 and the other of 30 lights capacity. All arc lights are of 1200 c.p. 6.6 amperes. The power at this station is derived from a double Pelton wheel under a head of 50 ft.

The Cartago plant, operated by the same company, is situated at Cartago, a town of about 8,000 inhabitants and the original capital of Costa Rica. This plant contains the T.-H. 30-light arc machine, originally in the San José arc station, one Westinghouse 60-light arc machine and one of the Westinghouse single-phase alternators, originally at the Anonas plant. All these machines are belted to Pelton wheels.

The incandescent light current in San José was originally supplied to the buildings from a large number of small transformers at 52 volts. These transformers have all been changed and now 104 volts are used. In the principal part of the city all buildings are supplied from three-phase secondary mains. These mains are connected at frequent intervals to 7.5-kw. transformers, which transform the current from 2200 to 104 volts.

The main line of the tramway is from the Costa Rica Railway Station, through the central part of the town to the Sabana, a large tract of public land on the western outskirts of the city, and used as a park. There are also two short branches, one to the cemetery and one to the Houses of Correction. All track through the city is laid with 72-lb. girder rails on steel ties. Outside of the city 58-lb. T rails with hard wood ties are used. The rail joints are special 36 in., 6-hole, bonded with Atkinson 0000 safety rail bonds. All poles are of iron and the overhead construction is supported from flexible brackets. The trolley wire is No. 0, fed at frequent intervals from a No. 00 feeder.



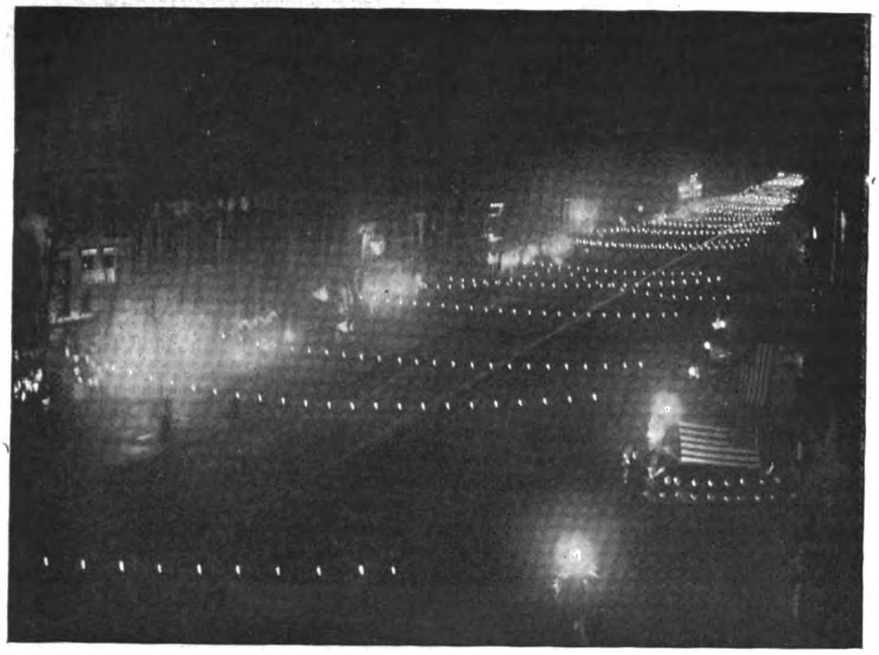
THE MOTOR-GENERATOR AND SWITCHBOARD OF THE TORRES STATION.

The opening of the tramway excited great interest among the natives, a great part of whom had never seen an electric railway, and now they regard as indispensable what a few months ago did not exist to them. They are very fond of riding and a large number ride on the tramway, as they have for years on the railway, merely for amusement.

The Costa Rica Electric Light and Traction Company, Ltd., is an English company, and was promoted and organized through the energy of Mr. Minor C. Keith, who was the builder of the Costa Rica Railroad, and to whom the country is indebted for much of its development.

It is to Mr. H. T. Purdy, of the General Electric Company of the U. S. A., the manager of the company, that I am indebted for the details of the equipment.

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# The Electrical Illumination in San Francisco.

BY CLARENCE L. CORY.

The electrical illumination in San Francisco, in connection with the reception to the First California Regiment on its return from the Philippine Islands, was in many respects the most extensive illumination ever arranged for temporary use. On the two evenings of the illumination the business portion of the city seemed a vast exposition; the many colored incandescent lights along the main streets and on the principal public buildings reminding one of the electrical illuminations at the World's Fair. The Citizens' Committee arranged and planned the public illumination, and its efforts were ably seconded by many large business firms and the newspaper offices. The private electrical displays were numerous and extensive; many of them operated entirely from isolated plants. The City of Stockton installed a 500-light plant, complete, in San Francisco, solely for the occasion to operate the lights used in its display. This was necessary, because the great demand just at this time for lamps and electrical energy made it impossible to carry out the scheme, using power from the San Francisco stations.

For the general illumination 9630 sixteen c. p. lamps and two 75-ampere searchlights were installed and operated from the central station of the San Francisco Gas & Electric Company. This is a three-wire 110-volt, direct-current system, with an auxiliary storage battery. In addition to these lights between one and two thousand lamps were also operated from this station for private displays. This large additional load was met by the station men very successfully, as the load upon the plant during the Christmas holidays has been even greater than it was at this time. The maximum amperes during the illumination was 23,400, while in December of last year the load was 26,000 amperes.

The illumination of Market Street from Eighth Street to the Ferry building, a distance of two miles, was, in many respects, the most interesting. Incandescent lamps were strung across the street, 24 in a row; these strings of lamps being spaced 50 feet apart along the street. At the intersection of cross streets the row of lights were elevated in the center, and these suspended rows contrasted beautifully with the strings across the street. Four thousand six hundred lamps were used in this way along Market Street, and the scheme of connecting in the different sections is shown in Fig. 1. Underground three-wire mains extend along Market Street, the feeders coming in at cross streets. Electric light and telephone poles, however, extend the entire length, and upon these were strung three No. 6 B. & S. copper wires. The different sections of lights were connected in on these wires, as shown, service switches being placed where needed on the poles. The section of lamps marked A is controlled by switch A; the section of lights in each case being designated with the same letter as the switches. Either switch marked D controls both sections of lights, D and D. It will be noticed that the underground neutral is directly connected with the over-head

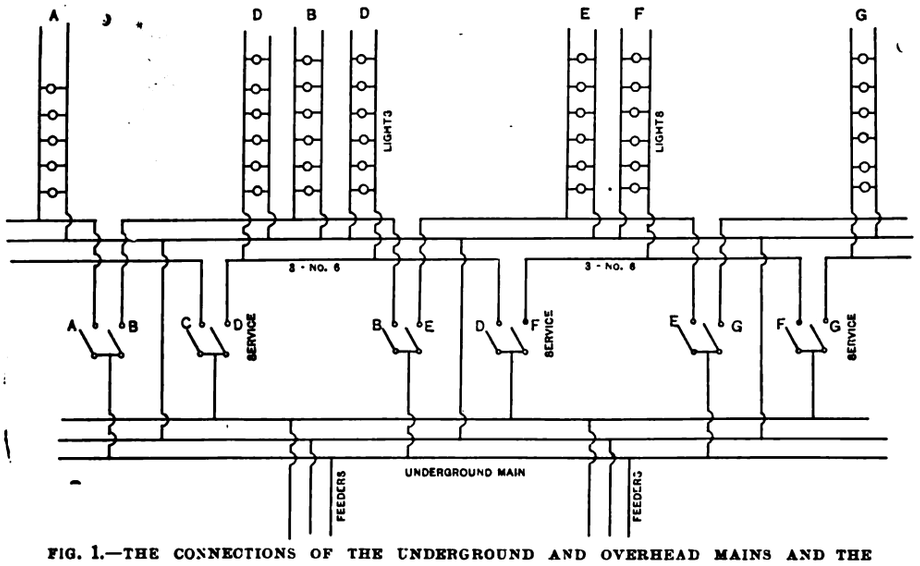



FIG. 1.—THE CONNECTIONS OF THE UNDERGROUND AND OVERHEAD MAINS AND THE ARRANGEMENTS OF SWITCHES.

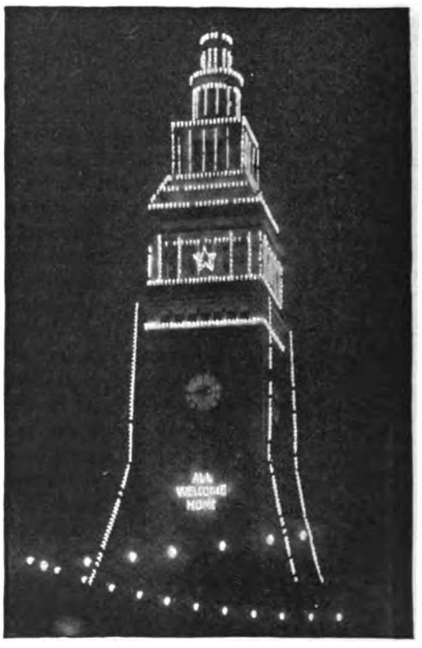


FIG. 3.—THE TOWER OF THE FERRY BUILDING.

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neutral, the lamps placed in on each side giving a perfect balance to the system.

In each string of 24 lights a fuse was placed, the fuse block in many cases being simply a small piece of wood in which were inserted two ordinary wood screws. The fuse wire was stretched between these two screws and connections made to the No. 14 B. & S. bare copper wire, to which the lamp receptacles were connected. As enough receptacles could not be obtained in the short time allowable, 5000 wooden sockets were made for this work and in no case failed to give satisfactory service. In this planning it was, of course, well understood that rain at this season was practically impossible, but the dense fog which was experienced during the installation did not interfere in the least with the operation of the lights. For temporary work, finished in such a short time, the results were very good; not more than twenty-five lamps, out of the entire number installed, failed. The illustration at the head of page 506 is a photograph giving an idea of the effect of the streamers of lights across the street.

On the tower of the Ferry building 2088 lamps were used. This building just at the foot of Market Street is shown in Fig. 3. From the bay the tower was the only portion of the illumination to be seen, while looking down Market Street the tower was the culmination of the street lighting, producing a splendid effect. The interior of the Ferry building was lighted from the plant of the Mutual Electric Company, the beautiful artistic effect of the lighting of the east nave being shown in Fig. 4.

On the dome and upper columns of the City Hall 3000 lights were installed. The great height of the dome and its elevation near Eighth Street made it the most conspicuous building of the illumination. Fig. 5 gives a good idea of the form of the building and the arrangement of the lights.

The most extensive as well as the most beautiful private display was the "Examiner" building. Three thousand lights were used, operated from the isolated plant in the building. Red, white and blue incandescent lamps were used with beautiful effect, the entire scheme being most admirably planned. All of the construction work and wiring in connection with this display was done in the very best manner possible, and could have been used for an indefinite length of time.

## THE ADVANTAGES OF LONG FILAMENTS IN INCANDESCENT LAMPS.

When it was recognized by Edison and his co-workers some twenty years ago that the incandescent lamp was not suited for series work, but should be run on multiple constant-potential circuits, it was at once seen that these constant-potential circuits should be of as high a voltage as lamp construction would permit in order to make possible the distribution of the current over any reasonable distance from the dynamos. After considerable experimenting it was found possible to make lamps of a resistance high enough to withstand 100 volts, and this, with a margin of a few volts for full measure, making it 110 volts, came to be the standard recognized pressure of incandescent circuits.

During the twenty years since that time the incandescent lamp has been the object of as elaborate investigation and experimentation as any other one product of the mechanical arts, an enormous amount of time, money and labor having been spent in its development, and with no mean results; but even at the present day, although lamps can be made for 240 volts, difficulties are encountered in making as good a lamp for the original standard pressure of 110 volts as can be made for lower pressure.

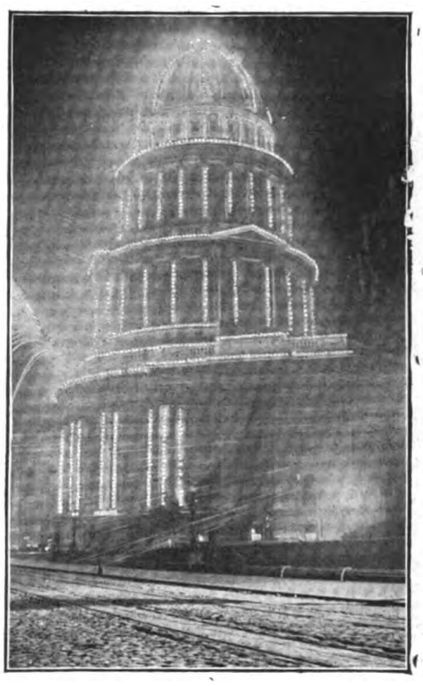


FIG. 5.—SAN FRANCISCO CITY HALL, SHOWING THE LIGHTING OF THE DOME AND COLUMNS

One of the difficulties in the way of raising the voltage of incandescent lamps may be illustrated as follows: Assuming that the lamp is to be of 16 c. p. and of 3.5 watts per candle, its total consumption of power will be 16x3.5, or 56 watts. If burned on a circuit of about 56 volts this power will require 1 ampere and the resistance of the lamp filament will have to be about 56 ohms. If, however, it is to burn on a circuit of 112 volts the power can only be kept down to 56 watts by cutting down the current to ½ ampere and the resistance of the lamp will have to be raised to 224 ohms. Thus it will be seen that doubling the voltage increases the necessary resistance 4 times; which is in accordance with a general law of purely resistive apparatus that the resistance must be varied as the square of the pressure to maintain the absorbed power constant. If the lamp is designed for a 220-volt circuit the current will have to be reduced to about ¼ of an ampere and the resistance will have to be raised to the extremely high value of practically 900 ohms to give the same economy of current. As the resistance of the carbon falls with increased temperature, the resistance cold is practically twice this, or, in the last case, 1,800 ohms.

The only way to obtain the high resistances of from 200 to 300 ohms necessary for lamps of 100 to 120-volt circuits is by using either a material of high specific resistance or of great length and fine diameter. Extended experiments in the di-

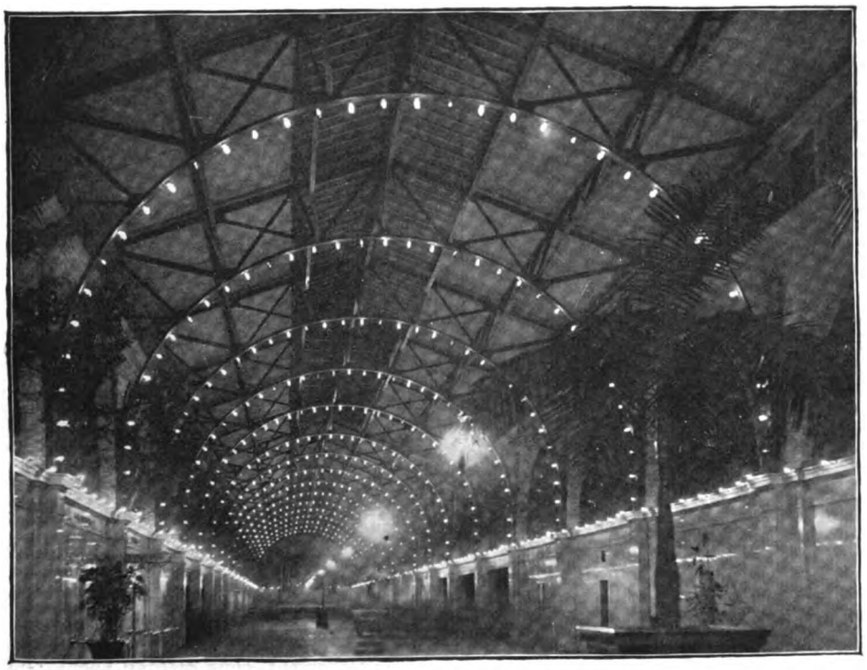


FIG. 4.—A VIEW OF THE INTERIOR OF THE FERRY BUILDING AT THE FOOT OF MARKET ST., SAN FRANCISCO.

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rection of finding a suitable material of high specific resistance by means of incorporating more highly resistive substances with carbon, or otherwise, have uniformly proven in vain, the only material as yet found available being carbon in two of its allotropic forms. One of these is a variety similar to very dense charcoal, and formed by the carbonization of the original cellulose thread of which practically all filaments nowadays are made. This form is known by lamp makers as "base" carbon. The other is a form of carbon closely resembling ordinary graphite.

All lamp filaments must contain as a foundation a central core of the former, or "base" carbon, filaments constituted wholly of graphite being impossible to make, since the graphite can only be obtained in the filament form by depositing it upon a skeleton structure of "base" carbon. This deposition is done by means of what is called the "flashing" or "treating" process. The carbonized cellulose thread is raised to high incandescence by electric current in a chamber through which is passed a current of gasolene vapor. The white-hot filament decomposes the hydrocarbon vapor, depositing the carbon as graphite upon its surface.

The "base" carbon has about six times the specific resistance of the graphitic carbon, so that filaments consisting wholly or largely of the former can be made much shorter and thicker for the same resistance than those containing a greater percentage of graphite. Unfortunately, however, the "base" carbon is much poorer in the qualities of economical light emission and life. This is not due, as many suppose, to any difference between the light-giving powers of graphite and charcoal; in fact it is generally admitted that all substances, no matter what their color, white, gray or black, shine with the same intensity when raised to the same temperature of incandesence. But the graphite gives to the surface of the carbon a gray, metallic, steel-like appearance which can be plainly seen in all new lamps, and this gray surface, in conformity with a general law of physics, radiates much less heat when raised to a given temperature than does a dead black or sooty surface such as that of the "base" carbon or that of an old lamp in which the surface of the graphite may have been reduced to the charcoal form. A filament therefore with a metallic gray surface requires less energy to supply this heat waste and raise it to the proper temperature of incandescence, such as for example as to radiate one candle power for every 3½ watts supplied, hence the superiority of the graphite for the economical emission of light.

Another superiority of the flashed or treated filament is mechanical. The graphite tube or sleeve which surrounds the "base" carbon is more dense and stiff than its central core, and hence holds the filament more rigidly against vibrations which tend to throw it against the glass, and also prevents it from sagging when the lamp is burned in a horizontal position. The graphite tube, deposited as it is at a high temperature, is a good resistant of the disintegrating effects of heat, and maintains the filament probably after the core of "base" carbon within it is broken down, thus greatly prolonging the life.

As stated above, the graphite is a good conductor of electricity as compared with "base" carbon, and hence if much of the cross section of the filament is graphitic the diameter of the whole will have to be small and the length great in order to obtain the necessary 200 or 300 ohms. The greater the amount of graphite and the less the amount of "base" carbon the better is the lamp for reasons pointed out above, and the general rule may be laid down that for a given voltage a lamp with a long filament is better than a lamp with a short filament, provided—and this is an important provision—the long filament is properly supported.

From the inception of the industry until

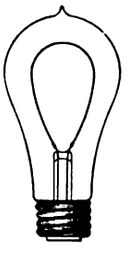


FIG. 1

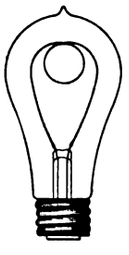


FIG. 2

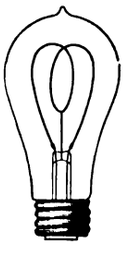


FIG. 3

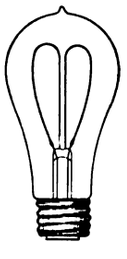


FIG. 4

a few years ago most incandescent lamps had filaments of the plain loop or horseshoe type, such as is shown in Fig. 1 of the accompanying cut. The filaments were thick and short, and little or no treatment was employed. As the superiority of the longer type became apparent the filament was given a loop or coil which allowed its length to be increased without enlarging the bulb, and its percentage of graphitic low-resistance carbon to be increased with it, so that this filament took the familiar form shown in Fig. 2. A variation upon it was the addition of more turns in the coil.

While this form is still made, it is largely giving way to another type developed by increasing the diameter of the coil and anchoring its lowermost point as illustrated in Fig. 3, this being known as the oval anchored type. This allows a further increase of the length and percentage of low-resistance graphite and is made in spite of several disadvantages. One of these is the impossibility of practicably anchoring the filament during the process of flashing so that unsupported this process cannot be carried on at as high a heat as is desirable without badly warping the filament. The graphite deposited is more dense and stable with the higher temperatures of flashing which cannot be obtained on the oval anchored filament. The cement used at the anchored point also causes trouble. This point being distant from the glass supporting the anchor wire and being heated in two directions and cooled in only one rises to a high heat, throwing off gases within the bulb which combine with the carbon on the surface of the filament to darken the latter, thereby tending to spoil the metallic gray finish which gives the lamp a high efficiency by reducing the amount of energy necessary to maintain the filament at the proper temperature as pointed out above. In spite of these faults, however, the perfected oval anchored type is far superior to its predecessors, solely because a greater proportion of the filament's bulk is of the purer, denser form of carbon.

A further step in the support of long filaments is taken by making the filament in two pieces connected in series with each other as shown in Fig. 4, which illustrates what is commonly known as the double filament type. This double filament consists practically of two 8-c.p. 50 to 60-volt filaments connected in series with each other by means of a short piece of wire bedded in the glass and cemented at its two ends respectively to one end of each filament. In this lamp there is no oval coil to twist out of shape and short circuit on itself. The loop shape of the two filaments allows the deposit of graphitic carbon to be made at a higher temperature, making it dense and hard and durable.

For high voltage lamps, that is, those intended for 200 to 240-volt circuits, mechanical difficulties of course arise in making and supporting filaments of twice the length and half the cross section of those for 100 to 120-volt lamps. The result is that comparatively little or no "treatment" can be applied to such filaments without making their resistance too small, which accounts for their failure to equal 100 to 120-volt lamps in the qualities of efficiency and longevity. Still other expedients of support have to be used with these high voltage filaments such for example as anchoring two points, etc.

An idea of the proportions of graphitic to "base" carbon in modern 3.1-watt, 16-c.p., 100-volt lamps can be gained from the fact that lamps of the oval anchored type are treated down to approximately 1/3 of the original resistance of the base of the filament while those of the double filament type are treated down to less than ¼ of the original resistance, this reduction being accomplished by depositing a tube or sleeve of graphitic carbon with a thickness of about 1/10 of the diameter of the finished filament, thus making about 1/3 of its cross section graphite, the inside 4/5 diameter or 2/3 cross section being "base" carbon.

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## SWITCHBOARD CONNECTIONS AND SYNCHRONIZING ARRANGEMENTS FOR POLYPHASE GENERATORS.

In the wiring of the generator panels of switchboards handling polyphase alternators there is an innumerable number of possible combinations of the voltmeters, instrument transformers and plug receptacles and lamps to measure the voltage of the various phases, synchronize the several machines and detect grounds. In the early days of polyphase apparatus each individual plant had its own scheme of connections, and, unfortunately, even now each house manufacturing polyphase machinery not only differs from the others in this regard, but has itself several different schemes of connections. Every dynamo tender in a polyphase plant should be able to trace the circuits of his switchboard and understand the purpose of each wire and connection so as to be able to trace trouble when it occurs or renew or replace the wiring when it becomes deranged. The following description of several arrangements used by the Westinghouse Electric & Manufacturing Company may help attendants in stations using Westinghouse apparatus to understand the circuits of their boards.

Various different schemes of wiring have necessarily to be used for different types of generating machinery. Two-phase boards must differ from three-phase boards as the number of bus bars is different, as well as the number of phases to which the voltmeter must be thrown. Boards for high tension circuits must differ from those for low tension circuits, as the former require instrument transformers in all cases, while with the latter the instruments may be connected directly to the machine terminals and bus bars.

Fig. 1 shows the general scheme of connections of high tension two-phase 4-wire generators, connected for running in parallel. But one set of bus bars is shown, the added arrangements necessary for two sets of buses being easily worked out for any individual case. The machine terminals are connected through four fuses and a four-pole switch to the buses, there being an ammeter in one leg of each phase. Branching from the two terminals of phase B of each machine are wires leading up to a small switchboard transformer. This transformer in each case feeds a pilot lamp for that machine and leads run from it to a voltmeter receptacle and to the synchronizing apparatus.

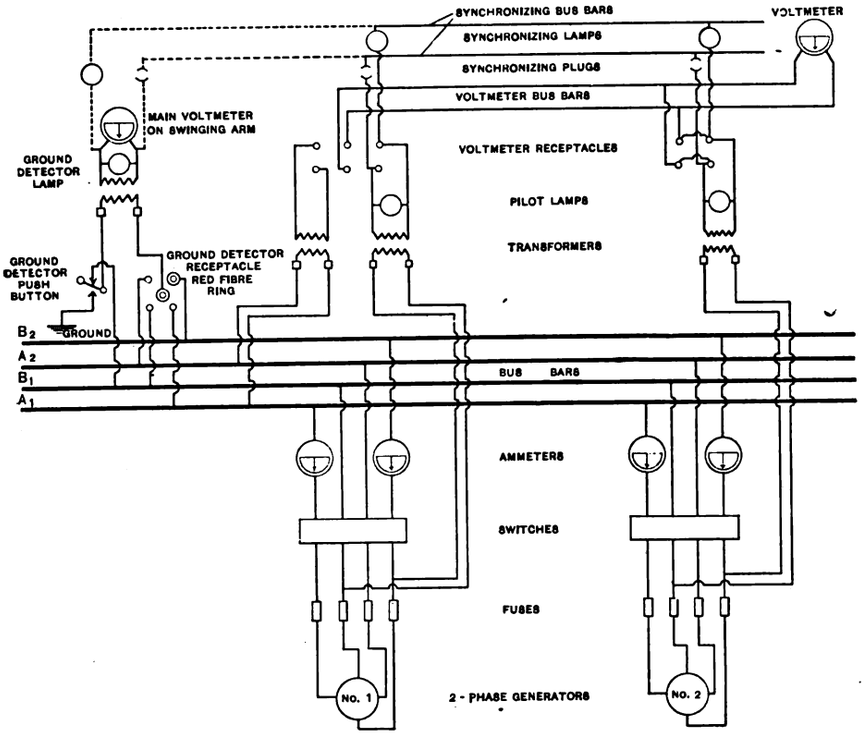



FIG. 1.—THE CIRCUITS OF TWO HIGH TENSION, TWO-PHASE GENERATORS.

Taking up the former instrument first, the connections made when the plug is in the receptacle are shown in that of machine No. 2. One side of the secondary of the switchboard transformer is connected to one of the voltmeter bus bars and the other side to the other, throwing the voltmeter at the right hand side of the diagram on to the secondary of the switchboard transformer connected with phase B of machine No. 2. By pulling out the plug and inserting it in the right hand four sockets of the receptacle on the panel of machine No. 1 the voltage of phase B of that machine will be measured. By moving it over to the left hand four sockets of the same receptacle connections are made between the voltmeter bus bars and the secondary of a small transformer, whose primary is connected across the bus bars of phase A. In this way the voltage of that phase upon the bus bars may be measured at any time.

The synchronizing is done by means of the usual lamps, one on the panel of each machine, and synchronizing plugs, one for each machine. By inserting the plugs on the panels of both machines Nos. 1 and 2 it is readily seen that the secondaries of the switchboard transformers for these two panels are placed in series with each other through the two synchronizing lamps and the synchronizing bus bars. This gives the lamps the usual beats while the machines are out of step, and steady conditions of glow or darkness when the machines are in synchronism and in proper phase relation. With any number of machines connected in the same way to the same synchronizer bus bars any two can be synchronized by inserting the proper plugs. This can be done while the same transformers that feed the synchronizing lamps are simultaneously lighting the pilot lamps and at the same time any one of them may be connected to the voltmeter.

To the left of the diagram is shown the main voltmeter, which is usually supported on a swinging bracket, and the ground detecting apparatus. This voltmeter and ground detector lamp are connected across the secondary of a switchboard transformer, the primary terminals of which go respectively to the middle terminal of a two-way push button and to the center point of a four-way ground detector receptacle. This receptacle is so built that the plug which fits it may connect the center point with any one of the four points grouped around it, these four points being respectively wired to the four bus bars. By placing the plug between the center point and that connected with $A_2$, for example, and depressing the ground detector push button, the primary of the transformer is connected between bus bar $A_2$ and the ground. If $A_1$ is grounded the ground detector lamp will light and the main voltmeter will show the pressure between $A_2$ and the ground. Similarly each of the buses can be tested for grounds by revolving the plug in the ground detector receptacle from one to another of the four points.

Normally, this plug is left in the upper right hand point, which is distinguished on the switchboard by a red fibre ring. In this position one terminal of the transformer primary is connected to $B_2$, the other terminal being connected through the back contact of the push button with $B_1$. In this condition the transformer and the main voltmeter are properly connected to measure the pressure of phase B on the bus bars, which measurement may be checked at any time by means of the other voltmeter through one of the voltmeter receptacles. The ground detector lamp under this condition becomes a bus bar pilot lamp for phase B.

The dotted connections which join the secondary of this transformer through a synchronizing lamp and plug with the synchronizer bus bars are for use in case there is another source of supply of cur-

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rent to the same bus bars, as from another or auxiliary station. In this case the transformer of the main voltmeter becomes a synchronizing transformer for the bus bars, so that they can be synchronized with any of the machines. When there is no auxiliary source of current this arrangement is not necessary, as one machine can be synchronized with another through their respective switchboard transformers without regard to the bus bars.

The arrangement for three-phase generators is materially different from this and is shown in Fig. 2. Here each machine is connected with the three buses through three fuses, a three-pole switch and three ammeters, one in each leg, to indicate any unbalancing of the load. From two of the terminals, A and B, of each machine between the fuses and the main switch there are tapped off two wires to the primary of a switchboard transformer. The secondary of this transformer, as before, feeds a pilot lamp and is connected to synchronizing plugs and voltmeter receptacles. One side of the secondary of each of these switchboard transformers is connected to a common bus or lead which may be distinguished on the diagram as wire No. 3, which also leads to one terminal of the secondary of another switchboard transformer shown at the right hand side of the diagram, the primary of which is connected to bus bars B and C. The other side of the secondary of this transformer is connected with wire No. 2, which runs to all the voltmeter receptacles.

The arrangement is a highly ingenious

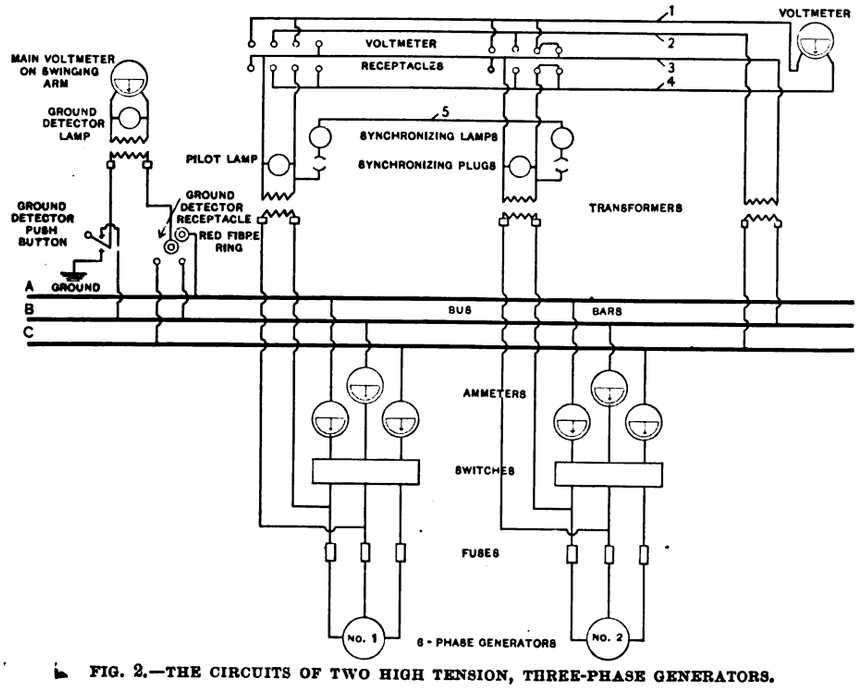



FIG. 2.—THE CIRCUITS OF TWO HIGH TENSION, THREE-PHASE GENERATORS.

one which allows the voltmeter by merely moving the voltmeter plug from one to another of the points of one receptacle, to measure the voltage across any one of the three phases. The way in which this measurement is effected is difficult to explain and must be studied out by each reader for himself. An idea of its operation may be given as follows:

When the voltmeter plug is in the right hand four sockets of the receptacle on the panel of machine No. 2 (as it is shown in the diagram) the voltmeter bus bar No. 4 is connected to the right hand terminal of the switchboard transformer of machine No. 2 and voltmeter bus bar No. 1 is connected to the common left hand terminal of all the switchboard transformers. The voltmeter therefore gets the pressure between terminals A and B of machine No. 2 whether that machine is connected to the main bus bars or not. By lifting out the voltmeter plug and inserting it in the other or left hand four sockets of the same receptacle, voltmeter bus bar No. 1 is connected with wire No. 2 and voltmeter bus bar No. 4 is connected with wire No. 3. This obviously gives to the voltmeter the pressure of the phase between bus bars B and C. By again lifting out the plug and inserting it in the middle four sockets of the same receptacle, voltmeter bus bar No. 1 is connected again with wire No. 2, but voltmeter bus bar No. 4 is connected with the right hand terminal of the switchboard transformer of machine No. 2. A little study of the connections will show that this gives a circuit through this switchboard transformer and that at the right of the diagram in series with each other. Provided that machine No. 2 is running and connected to the bus bars, this gives to the voltmeter in series two polyphase electromotive forces out of phase with each other, viz., those between bus bars A and B, and B and C. The resultant of these two component electromotive forces must, by a fundamental law of such systems, be the electromotive force of the third phase between bus bars A and C. Thus by moving the plug along between the various sockets of the 8-pointed receptacle any one of the three phases can be measured. Phase A-B of each machine can be measured while that machine is or is not running on the buses; phase B-C can only be measured upon the bus bars and phase A-C can only be measured with a machine upon the bus bars.

The synchronizing arrangement is equally ingenious. By inserting the synchronizing plugs in the panels of the machines to be synchronized a circuit is

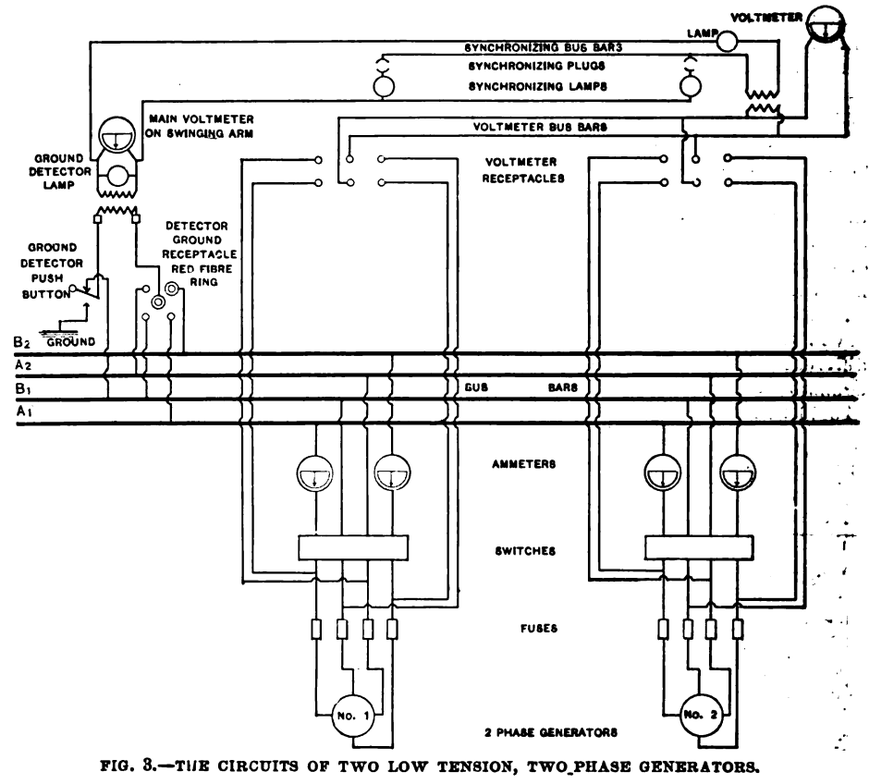



FIG. 3.—THE CIRCUITS OF TWO LOW TENSION, TWO-PHASE GENERATORS.

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made through the secondaries of the switchboard transformers in series with each other and the synchronizing lamps and completed through wires Nos. 5 and 3, which circuit gives the proper combination of instantaneous electromotive forces to the synchronizing lamps.

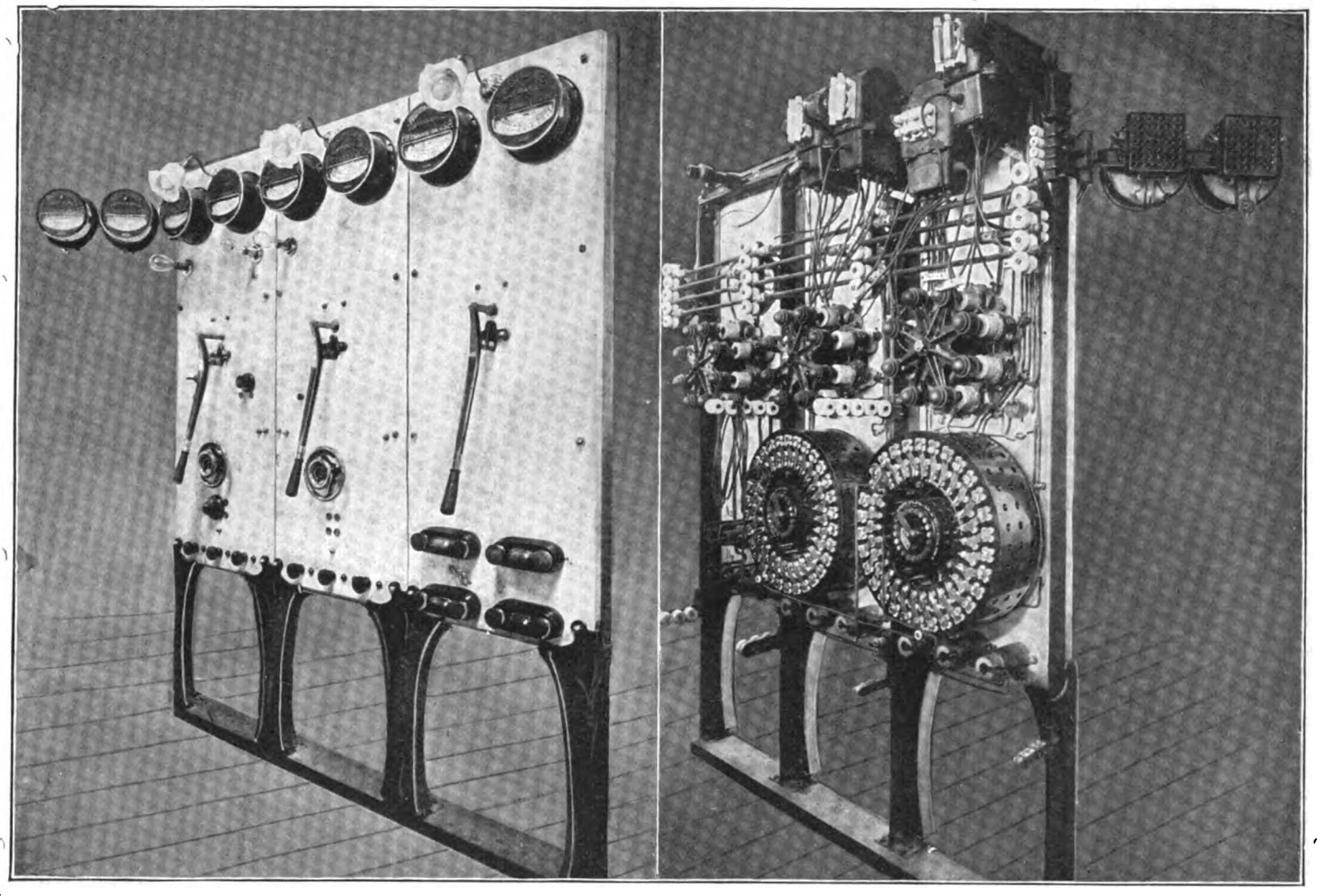
To the left of the diagram appears the main voltmeter and its ground detector lamp, transformer and push button, the arrangement of these parts being exactly as in the two-phase apparatus described above. The ground detector receptacle has in this case only four points, one central and three grouped around it for connecting the transformer primary with any one of the three bus bars. Normally the plug may be left in either the upper right hand or lower left hand point, giving the main voltmeter and lamp the voltage of phases A-B or B-C, respectively.

Alternating current machines are now often built for comparatively low pressures, that is those between 75 and 440 volts. For example, rotary converters and double current generators for railway circuits have three-phase outputs at about 330 volts. Alternating current three-wire systems fed direct from machines are also coming into use. For all such cases the system of switchboard connections must necessarily differ from those given above, as the voltmeters and pilot synchronizing lamps can be electrically connected with the machine terminals or bus bars without the interposition of switchboard transformers.

Fig. 3 shows the connections for low voltage two-phase generators. Here, as before, the machines are connected to four buses, but each panel in this case contains a six-point voltmeter receptacle, the two central points going to the voltmeter bus bars, the two points at one side going to the machine terminals of phase A, and at the other side to the machine terminals of phase B. With the voltmeter plug in one position in such a receptacle the meter gets the pressure of phase A, and in the other position the pressure of phase B of the corresponding machine.

Synchronizing is done by means of transformers, although these are not really necessary on low voltage machines; there being no switchboard transformers for each machine, two special transformers are provided and fitted for synchronizing any number of machines. This is accomplished by connecting one transformer to the main bus bars and the other to the voltmeter bus bars, which latter can be plugged to any machine. The former transformer is that shown to the left and combined with ground detecting devices similar to those described above. This transformer is also connected in series with the secondary of another, shown to the right of the diagram, the primary of which is tapped off from the voltmeter bus bars. The series circuit is completed through one fixed synchronizing lamp and a synchronizing plug and lamp on each machine panel. Obviously there is no need of plugging in a different lamp for each machine synchronized, but in order to bring the synchronizing signal on the panel of the machine to be synchronized the plug arrangement is used.

The arrangement for low voltage three-phase machines is shown in Fig. 6, page 512. Here but one switchboard transformer is used, the synchronizing being done entirely without transformers. The machines are connected, as usual, through fuses, switches and ammeters to the bus bars, and each leg of each machine is connected to the points of a voltmeter receptable, to which also run branches from the voltmeter bus bars. By inserting a four-point plug in the right hand four points of this receptacle the voltmeter is connected directly across one phase of the generator, the middle four points giving another phase and the left hand four points giving the third phase. The other receptacles similarly serve for the other machines. Thus each phase of each machine can be measured entirely independently of the bus bars.



FIGS. 4 AND 5.—FRONT AND REAR VIEWS OF A HIGH TENSION, TWO-PHASE BOARD, WITH TWO GENERATOR AND ONE LOAD PANELS, SHOWING THE APPEARANCE AND ARRANGEMENT OF THE DEVICES INDICATED IN THE DIAGRAM FIG. 1. FIG. 5 SHOWS ALSO THE CONCENTRIC MAIN AND EXCITER RHEOSTATS, THE PLUNGER-TYPE SWITCHES AND THE METHOD OF SUPPORTING THE BUS-BARS AND TRANSFORMERS.

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Two wires are carried the full length of the machine panels for synchronizing purposes, and one of these is connected with leg C of each machine through 4 lamps in series with each other, one on the front of the panel and three behind it. The other synchronizing bus is connected to leg A of each machine through a plug receptacle. By inserting two plugs respectively on the panels of the two machines to be synchronized a circuit is made through phase A-C of the two machines in series with each other and the 8 lamps. The machines being wound for 440 volts, the electromotive force in this circuit beats between 880 volts and zero when the machines are out of synchronism, and therefore illuminates and extinguishes the 8 lamps in series with each other until the machines are brought together. For lower voltages fewer lamps would be used. For instance, with 330-volt machines but three lamps in series for each synchronizing connection would be necessary.

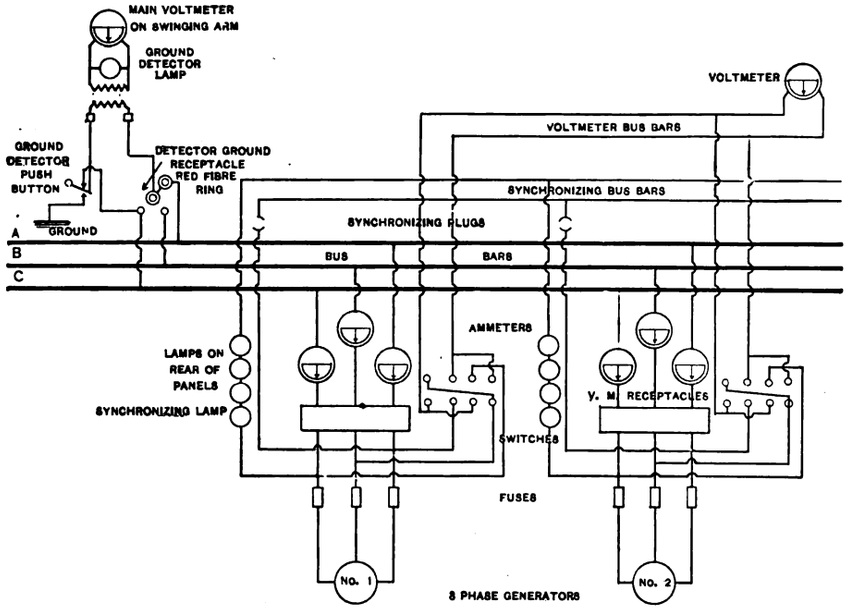



FIG. 6.—THE CIRCUITS OF TWO 440-VOLT, THREE-PHASE MACHINES.

The appearance and arrangement of the instruments on the boards are shown by Figs. 4 and 5, illustrating respectively the front and back of a two-phase, high tension board, containing two machine and one load or feeder panels. The two voltmeters are mounted on a swinging arm so that their indications may be read from any position in front of the board. The main switches are of the plunger type, with no live parts exposed on the front of the board. The two machine panels, as Fig. 5 shows, contain below all other instruments three plugs each. These are for the field circuit, to connect either one of the two exciters, and are capable of breaking the field current. Immediately above these are the voltmeter plug receptacles, that on the left hand panel being 6 point and holding, at the time the illustration was taken, the plug in the left hand 4 points. Above these are the rheostat handles, the exciter rheostats being concentric with the main rheostat and operated by concentric hand wheels. Above and to the right of the hand wheels on the left hand panel is the ground detector plug, this panel containing also one ground detector lamp in addition to the synchronizing lamp and the bracketed pilot lamp. The ground detector push button also appears on the front of the board. The right hand panel contains simply two ammeters, one in each phase, a main plunger type switch and four lignum vitae fuse blocks, one in each leg of the two-phase system.

## A COMBINED TROLLEY AND STORAGE BATTERY LOCOMOTIVE FOR MINES.*

The numerous accidents to mules coming in contact with overhead trolley wires in mines have raised a demand for some sort of a system whereby the animal will become an unnecessary evil in the operation of a mine. To construct a bonded track and stretch a trolley wire to the face of all workings would be too expensive for general mine practice, and, in consequence, it is the custom in some mines to use a small mine wagon and have the miner push it to and fro from face to parting, from which place it is taken with the locomotive. In order to eliminate the mule from the mine and haul from the face of all workings, a combined storage and trolley locomotive has been devised, whereby the heavy work on headings is done from trolley, and while so running the attached battery, which is carried in circuit, absorbs sufficient current to do the necessary room work. Such a locomotive, the only one of its class, was built by the Baldwin-Westinghouse combination for the Southwest Virginia Improvement Company, having the following dimensions:

| | |
|---|---|
| Gauge | 36 inches |
| Width over all | 42 " |
| Height, including battery box | 44 " |
| Length | 124 " |
| Weight, including battery | 9,000 lbs. |
| Electric equipment | 2 10-h. p. motors |
| Rheostatic controller. | |

This locomotive was designed to haul on the level one loaded car weighing 9,000 pounds on storage, and was accordingly equipped with 90 5-D. cells, and having mounted therewith a special battery circuit breaker, etc.

After the locomotive was built the mine manager changed his plans and concluded to try it in a part of the mine where the battery would be required to handle loaded cars up a 4 per cent. grade and empties up 8 per cent. In addition, the trolley line was an extension of the feed line for some ten or twelve mining machines, in consequence of which the voltage varied from 110 to 200 and the battery would either feed back into the line or throw the circuit breaker. In order to prevent the latter it was so adjusted that it would not fly out, and the battery was virtually short circuited a large number of times each day without any bad effect. With this condition of affairs it was impossible to hold sufficient current in the battery to do the desired amount of room work, and it became necessary to stop a total of about thirty minutes each day for renewals. It must be remembered that this work was under the supervision of a mine foreman unacquainted with storage batteries. Having gone to such extremes in the use of this locomotive it was suggested that a new and independent feed line would be a great improvement; it was installed, with marvelous results. The voltage became constant, and, the battery often discharged for a short time at three times its rated capacity; yet the work has been ideal, and after almost three months' service there is no appreciable wear on the battery. It produces a tractive effort up to the point of adhesion of the locomotive when working on storage, and the regular work is to take seventeen empties weighing 60,000 pounds, including locomotive, from side track up a short 1 per cent. grade, then down a 4 per cent. to a level, from which place it starts to distribute in rooms having a maximum of 8 per cent. in favor of loads. After distribution it proceeds to collect the loads in trips of two cars each, on account of the 4 per cent. grade against loads on heading, and deliver them to the side track while working on trolley. In this manner this one locomotive is capable of delivering to this side track, over an average round-trip haul of 4,000 feet, 200 loaded wagons daily direct from face of working, which is the work, under existing conditions, of 12 mules and 8 drivers. It is the intention to place a night force, and if sufficiently large, the saving will be the care of 24 mules and time of 12 men, or an amount equal to $8,000 annually.

This same company has placed an order for six more of the same class of

*Extract from paper read by Harry K. Myers before the Engineers' Club of Philadelphia.

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locomotives, and is considering the matter of constructing heavier ones of the same kind to take the place of steam locomotives now in use, but which are very injurious to both the ventilation of the mine and the timber work.

## Among our Foreign Contemporaries

**The Seasoning of Wood with the Aid of Electricity.**— In the treatment of wood by usual methods, with either preservative or fire-proofing compounds, the wood must first be thoroughly kiln dried, after which the compound must be forced in under high pressure and temperature, and even then the penetration is not very deep. M. Nodon-Bretonneau has developed a means of accomplishing this result more thoroughly and rapidly by the use of electric currents, which seem to cause a sort of endosmotic carriage of the treating liquids into the fibers of the wood. The arrangement of an extensive plant for this purpose was recently described in "La Nature," from which the following description and the illustration, Fig. 1, have been taken. The treatment is carried out in a large wooden vat, the bottom of which is lead-lined and connected with the positive terminal of a direct-current dynamo. The wood is piled criss-cross, within the vat, upon a supporting framework with a false bottom, which is maintained at any desired elevation by means of hydraulic jacks, acting upwardly through the bottom of the vats. On top of the upper layer of wood there is lowered a large tray with a felt bottom and an extended sheet electrode, which is connected with the negative terminal of the dynamo. The vat is filled up to the level of the wood, but not up to the level of the upper tray, with the solution with which it is desired to replace the sap of the wood, the solution being either a preservative or fire-proofing material, according to the purpose of the treatment. In the works at Aubervilliers, which are shown in the illustration, the solution is a neutral bororesinate of sodium. The application of the current causes an endosmotic action which carries the solution upwardly through the wood, driving out the sap ahead of it.

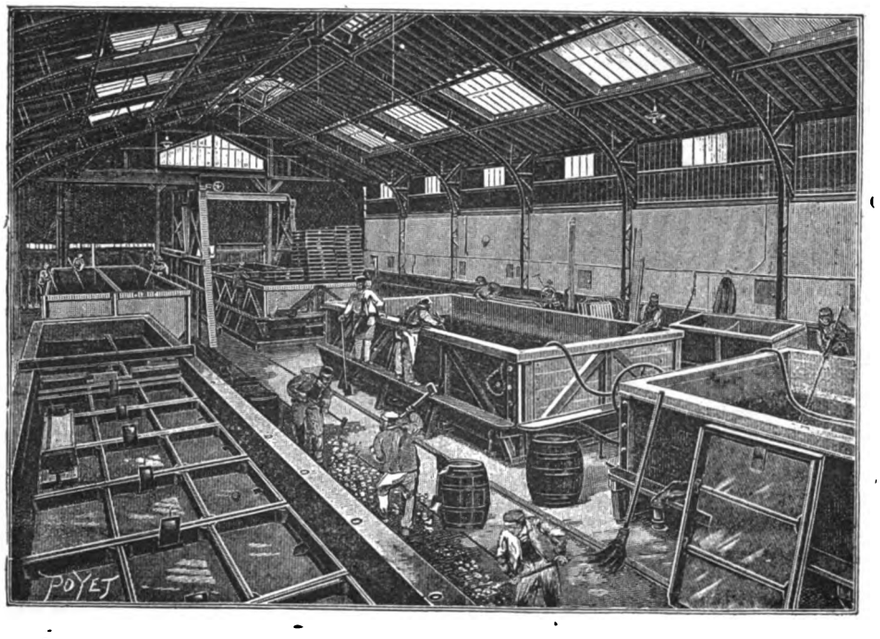



FIG. 1.—A FRENCH PLANT FOR THE ELECTRICAL TREATMENT OF WOOD WITH PRESERVATIVE OR FIREPROOFING COMPOUNDS.

**The Hartman-Braun Hot Wire Instruments.**—Owing to the fact that an English manufacturer has obtained the rights to manufacture and sell voltmeters and ammeters of the type covered by the Hartman-Braun patents, the English papers have been giving descriptions of these instruments which may be of interest also to American engineers since the same type was taken up here by the Stanley Electric & Manufacturing Company shortly before its consolidation with the Sprague Company. The instruments involve several interesting peculiarities which improve their operation over that of previous types and the method of adapting the hot wire principle to ammeter use is also interesting. Fig. 2 shows a general outline of the parts and their connections. The hot wire proper, shown at A A, is made of platinum silver about 6 or 7 ins. long, stretched between two terminals, T′ and T″, until it is almost taut. Near the center of this wire there is attached another wire of phosphor bronze, B B, running to a third terminal, T‴, at the lower part of the instrument. Branching from this phosphor-bronze wire is a cocoon fiber, C, which is looped around the jewel mounted steel spindle carrying the needle, and terminates in the spring, S, which maintains it taut. The whole arrangement of the fiber and wires is thus subjected to tension and any slacking or sag of the hot wire at the top is immediately taken up by the steel spring and transmitted by the motion of the cocoon fiber to the pointer. As is well known, when a wire is stretched nearly straight between two points the slightest change of its length causes a great change in the amount of slack. The arrangement of the platinum silver and the phosphor-bronze wires thus obtains a double multiplication of the deflection in this way, a third multiplication being given by the ratio of the length of the pointer to the diameter of the small spindle on which the cocoon fiber is coiled. Thus a very slight change in length of the wire, A A, causes a considerable movement of the pointer. In addition the ratio of the change of sag to the change of length becomes greater as the wire becomes straighter; thus the scale becomes more open at the higher readings. The whole of the hot wire movement is mounted on a metal compensation plate made from an alloy whose temperature coefficient is the same as that of the measuring wire. To deflect the pointer of the voltmeter over the full scale a current of .2 ampere is required. For voltmeter work a series resistance or multiplier of constantin is connected in series with the hot wire. For ammeter work the hot wire is tapped at several points by thin silver foil strips which divide it into sections, these sections being placed in parallel with each other. By this means four or five amperes may be sent through the wire with a drop of potential not exceeding ¼ volt (the ammeter hot wire being thicker than the voltmeter hot wire). For higher currents a constantin shunt is used. A magnetic damping arrangement is provided to prevent oscillations.

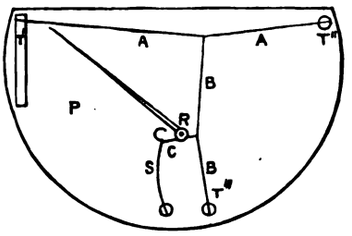



FIG. 2.—THE ARRANGEMENT OF THE HOT WIRE AND DEFLECTION MULTIPLYING APPARATUS OF THE HARTMANN-BRAUN INSTRUMENTS.

**A System of Train Lighting.**—When axle driven generators are used in connection with storage batteries for lighting cars or trains on steam railways some means must be provided for reversing the connections of the armature when the motion of the train is reversed, for discon-

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necting the generator when the speed becomes so low that it cannot maintain voltage, and for preventing the generator from delivering too high a voltage when the train runs very rapidly. For the last purpose two general plans have been developed by two different companies in this country. One is the use of a belt applied with a definite tension such that when the output of the generator becomes greater than a certain amount the belt will slip. The other consists of an automatically operated field rheostat. Still a third means of accomplishing the same result used upon cars now in service on the Paris, Lyons & Mediterranean Railway system was recently described in the "Revue Generale des Chemins de Fer." In this system the current from the generator to the storage battery and lamps passes through a series-wound motor on the shaft of which is a friction brake set up with a certain definite pressure. When the current flowing is small this motor does not turn, but when the current exceeds a certain definite strength, in this case 28 amperes, just sufficient to overcome the friction of the brake, the armature of the

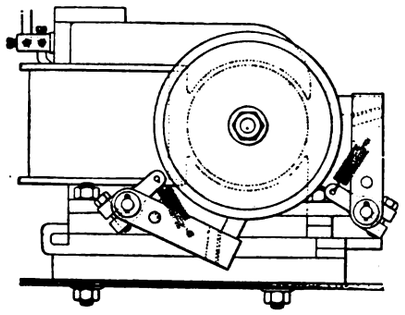


FIG. 8.—THE AUTOMATIC VOLTAGE GOVERNOR OF A SYSTEM OF AXLE DRIVEN GENERATORS.

motor begins to revolve. In case the train speed increases and with it the pressure of the generating dynamo, tending to increase the current delivered from the dynamo, the speed of the motor increases, keeping down the e.m.f impressed upon the storage battery and lighting circuit to a constant value, the back e.m.f. of the motor increasing automatically and just taking up the difference between the impressed e.m.f. of the generator and the proper e.m.f. which should be delivered to the storage battery. The regulating motor is illustrated in Fig. 2. The brake pulley is of bronze and the blocks which are pressed against it are of what would be considered in this country a very unusual material for this purpose, viz., carbon. This material was probably adopted to give a friction of rest more nearly equal to that when running than can be obtained with most materials.

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**Improved Joint for Conduit Systems.**—Mr. J. D. F. Andrews in "The Electrical Review," London, points out the well-known disadvantages of soldered joints insulated with rubber or rubber compounds, in conduit systems, and proposes the using of porcelain as insulation. The article describes and illustrates several fittings designed for this material. Fig. 4 shows a junction box where a 2-conductor wire is spliced. The two wires to be joined are bent upwardly and their ends are wrapped with fine copper wire and

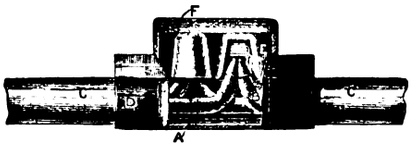


FIG. 4.—CONDUIT JOINT INSULATED WITH PORCELAIN.

soldered. Over this upward bend there is then placed a porcelain thimble, E. The metal cover, F, fastened by screws, encloses the whole, and may be made water tight by soldering or the use of red lead.

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**A Wireless Telegraph Patent.**—"The Electrician" of London describes some patents recently issued by the British Patent Office to Mr. Marconi. One of these claims an interesting improvement in Hertz wave working which consists of the use of an induction coil or transformer between the circuit of the vertical wire and the coherer. The purpose of this transformer is to raise the pressure of the oscillations sent in to the coherer, the low tension coil of the transformer being connected in the vertical receiving wire and the high tension coil in the coherer circuit. The arrangement is designed to make use of the discovery that the effect of electrical oscillations on a coherer seems to increase very greatly with their e. m. f., but not to be affected particularly by their current strength. This is due probably to the fact that the oscillations cause in the imperfect contacts of the coherer a local breaking down of the resisting films between the particles, and this breaking down is greater with increased e. m. f. The arrangement of the circuit is shown in Fig. 5, where c is the primary of the transformer inserted in the wire which, at b, leads to ground, and

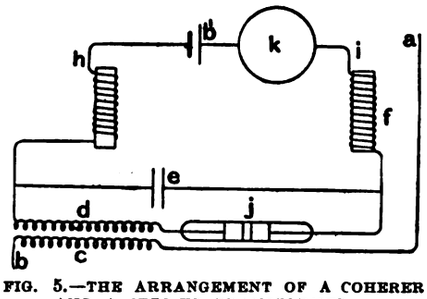



FIG. 5.—THE ARRANGEMENT OF A COHERER AND A STEP-UP TRANSFORMER.

at a leads to the overhead sphere. The secondary of the transformer is shown at d, in series with the coherer, j, and a secondary circuit for the oscillations is closed by the condenser, e; k is the indicator or relay connected in series with the battery and the coherer through the choke coils, f and h.

**Pollak-Virag High Speed Telegraphy.**—Interesting experiments with the Pollak-Virag system of telegraphy have recently been made between Budapest and Vienna, a speed of from 1300 to 1500 words per minute being obtained. A description of the apparatus recently appeared in "The Electrician" of London, from which the following points are abstracted. The transmission is accomplished by the ordinary strip of perforated paper, similar to that of the Wheatstone automatic, and a rather crude arrangement of contact brushes acting through the perforations. The main element of interest lies in the receiver, which consists of a coil acting upon a diaphragm like that of a telephone, this diaphragm actuating a small mirror which reflects light upon a photographically sensitive strip of paper. The arrangement of these parts is shown in Fig. 6, where the coil appears at the right actuating a diaphragm to the left of it. The small concave mirror of steel is made to oscillate through considerable angles for small vibrations of the diaphragm by pivoting it against a knife edge, forming one pole of a permanent magnet, the other pole of which ends in a weak spring at-

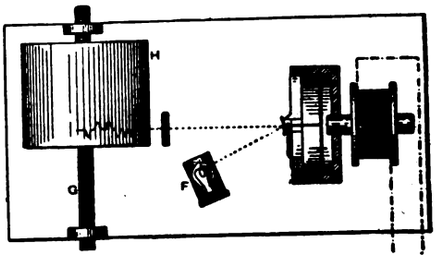



FIG. 6.—DIAGRAM ILLUSTRATING RECEIVING APPARATUS OF POLLAK-VIRAG TELEGRAPHY.

tached to the diaphragm. The steel mirror is held magnetically against the knife edge and the spring and the vibrations of the latter cause oscillations of the mirror about the knife edge as a pivot. This causes oscillations of the beam of light from an incandescent lamp, F, when reflected through a converging lens on to the sensitive paper, which is mounted on a drum, H. The drum is kept in motion so that the oscillations cause waves in the line traced by the beam of light. The drum is also carried axially a certain distance during each rotation by means of a screw thread on its spindle, so that many lines of the record can be obtained on one sheet. The electrical qualities of the telegraph line are improved for high speed work by shunting the receiving magnet with a condenser and the transmitting instrument with an inductive coil.

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**A Repeater for Wireless Telegraphy.**—To increase the range of wireless telegraphy an Italian, M. Guarini-Foresio, has designed an automatic repeater which was recently described in "L'Electricien." This repeater is so designed that when electric radiations from a distant station are intercepted by its vertical wire, setting up an action in its coherer, this coherer

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closes a relay circuit, which in turn excites the induction coil, sending out fresh waves from the same vertical wire and overhead sphere. Naturally the vertical wire must be instantly disconnected from the coherer when the induction coil is excited, and this is done automatically by means of another relay, the coils of which are placed in parallel with the primary of the induction coil. Whenever the induction coil is excited the armature of this relay is attracted, cutting off the coherer. The device appears to be practicable for repeating short impulses such as dots, but obviously would not work with the ordinary Morse code using dashes, since prolonged impulses coming through it would set in action its induction coil and thereby cut off the vertical wire from the coherer before the dash could be completed, thus repeating the prolonged impulses in a broken form.

**The Wehnelt Interrupter.**—The German papers have recently contained advertisements of a commercial form of the Wehnelt interrupter, made by Siemens & Halske. The appearance of this instrument is shown in Fig. 7. The platinum wire anode passes down through a vulcanite tube, the lower end of which ends in a porcelain cap through which the wire



FIG. 7.—A GERMAN FORM OF THE WEHNELT INTERRUPTER.

projects. The length of the projection can be adjusted by a thumb screw at the top. The cathode and anode are lowered into a square receptacle shown at one side of the illustration, this receptacle having attached to it a coiled tube for circulation of the electrolyte in a cooling bath contained in a larger enclosing chamber.

**A Novel Electro-Magnetic Brake.**—In a recent lecture on "Car Brakes," before the German "Electrotechnische Verein," Max Schiemann described what he termed with true German definiteness an "adhesion multiplying electro-magnetic rail brake combined with wheel shoe brake." This device consists of a number of magnets designed to exert their attraction upon the rail head to which they bind themselves, causing friction which checks the speed of the car. The general arrangement of the parts is shown in Fig. 8. The magnets consist of coils closed in a cylindrical metallic cover and alternately magnetizing north and south pole pieces, which project downward toward the rail head. The whole arrangement is flexibly supported and in the combination shown in the illustration is counterweighted, so that normally it rises away from the rail. When energized the magnet draws itself down to the rail and binds against it, the friction carrying it backward and under the rear wheel, a shoe attached to the magnetic device wedging itself under the wheel and thereby increasing the retarding effect. The magnet is preferably energized by current from the car motors acting as generators so that as the car approaches standstill the braking action is released and a jerky stop is avoided.

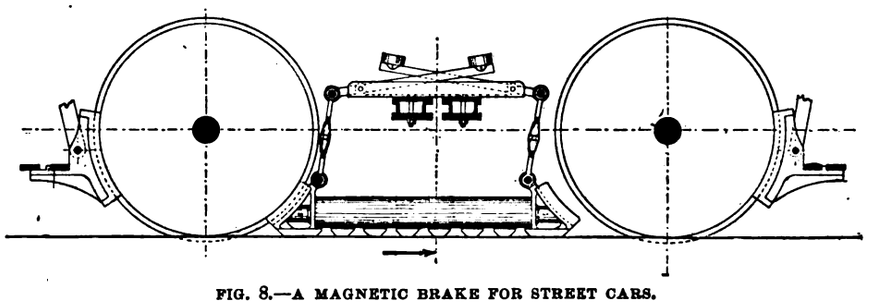


FIG. 8.—A MAGNETIC BRAKE FOR STREET CARS.

**Friction Losses in Dynamos.**—In several of the simplest methods of determining the efficiency of dynamos, it is very desirable to know the friction losses; these losses are also the ones which are more likely to change in the course of time, when the dynamo is in use; the laws concerning these friction losses and the determinations of their value are therefore of practical interest. A somewhat prolonged discussion concerning these losses has been continued in a number of issues of the "Elektrotechnische Zeitschrift," and one of the results has been a long article by Mr. Dettmar in which he goes into this subject very thoroughly and develops some points of practical value. One of the chief points which he brings out is that the loss of work due to friction is not proportional to the speed, as is often supposed, but that it increases quite appreciably with the speed; by this he refers to the sum of the various friction losses in the dynamo. This variation from a straight line law has been attributed to the air friction, but he shows that this is not correct, and that it is the coefficient of friction which is variable. There are three methods by which the friction may be measured, first by means of a calibrated motor, that is, driving the dynamo to be measured by means of a motor whose efficiency has been accurately determined. This method is not a good one if the motor drives through a belt, as that involves an unknown quantity in the form of the power absorbed by the belt; but if the machine is directly coupled, the method is a good one, but is limited; the calibrated motor, for instance, should not be heavily loaded by the machine which it drives; the method has advantages when no convenient source of current is obtainable for the other methods. The second method is the well known one of running the machine as a motor, unloaded, and has already been described; it combines great accuracy with relative simplicity. The third method consists in bringing the dynamo up to the proper speed either mechanically or electrically, and then letting it run down without doing any work other than overcoming the friction losses. The application of this method is, however, limited for absolute determinations, as it involves a knowledge of the moment of inertia, etc.; it is very serviceable, however, for determining relative values, that is, for comparing the losses at one time with those at another; moreover, the time required for making such a test is extremely short and this is of great value, as the other conditions, such as temperature, are not so likely to change during the test. If the losses are determined absolutely once for all, then the method serves very well for determining the condition of the bearings; moreover by observing the action of the machine during the last turn before it stops, indications will be obtained as to the balancing of the armature. Sometimes the combination of two of these methods is of use, as, for instance, by using the first or second in order to find the absolute values of the relative ones given by the third method. In the third method, which he calls the "running down" method, a tachometer (this is an instrument for indicating the speed at any moment) must not be used, as that absorbs considerable power; in place of it the remnant magnetism may be used in connection with a voltmeter. The speed is measured once for all while running, and also the voltage at that speed due to the remnant magnetism; then the voltage readings may thereafter be used as a measure of the speed, correcting it of course by the factor thus determined. Otherwise a revolution counter, like a bicycle cyclometer, could be used. From this very lengthy series of tests he draws the following conclusions: At a constant temperature of the bearings and a constant specific pressure (that is, a constant pressure per square inch) the friction coefficient, and therefore the loss of the work by friction, increases as the 1.5th power of the speed. The nature of the oil used does not change this law but merely affects the absolute values. The values for this exponent, which he found for a very large number of tests, varied between 1.3 and 1.55, the smaller one being for a smaller machine and the larger one for those of larger sizes.

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## THE STREET RAILWAY CONVENTION.

The annual convention of the American Street Railway Association was held this year in Chicago, on Tuesday, Wednesday, Thursday and Friday, October 17th to 20th inclusive. The convention headquarters and exhibit hall were at Tattersall's, a location well suited to the needs of the Association.

The number of papers to be read before the Association was, this year, unusually small in order to give ample time for discussion. The papers on the program numbered five, and but four of these were read. Another unusual fact about the papers is that none of them was upon an electrical subject. Following the custom set last year, the last day of the convention was specially set aside for the purpose of visiting the exhibits.

The entertaining and social features of the convention consisted of a reception in the parlors of the Auditorium Hotel Tuesday evening, a trip to the drainage canal Wednesday afternoon, a trolley ride to the Union Stock Yards Thursday afternoon, a theatre party Thursday evening, a trip to the power house of the South Side Elevated Railroad Friday afternoon and the usual annual banquet Friday evening.

### THE PROCEEDINGS OF THE FIRST DAY.

The convention opened Tuesday morning with the usual smooth running characteristics of the Street Railway Association, the meeting being called to order by President Sergeant. After an address of welcome by a representative of the Chicago city government, the President made his annual address, a portion of which abstracted herewith may be of interest to the reader of these columns.

### PRESIDENT'S ADDRESS.

Gentlemen of the American Street Railway Association: We are to-day assembled for the eighteenth annual gathering of our Association, and for the second time we meet in this great and prosperous city.

Those gentlemen who met here in Chicago in 1883, many of whom are, I trust, present today, could have had little conception of the changes in their business which were to occur before the end of this century. At that time there were in Chicago street railways operating about 153 miles of single track. At the present time the mileage of the surface street railways of this city is about 736 miles, of the Chicago interurban street railways about 261 miles, and of the elevated street railroads about 100 miles, either operated or under construction, making an increase since your last meeting here of 944 miles of track. This remarkable extension of street railways, their equipment with mechanical motive power, the unique union loop system, and the successful application of electric power in the elevated railway service, are not only a wonderful testimonial to the courage, energy and capacity of their projectors, but they have made Chicago a street railway Mecca to which we all may come to observe and learn. We are, therefore, to be greatly congratulated upon the advantages afforded us by the selection of this city for our convention.

The year which has passed since we met has presented some unusual features, which are worthy of our attention. The tendency towards consolidation of small or competing roads into larger homogeneous systems has been manifested by many examples. With the introduction of electric motive power the old-time horse railway company, operating a few miles of track on two or three city streets, has disappeared, and its larger successor has found necessary such changes in administration, such extensions of its system and service, that the advantages of combination with rivals have become more and more manifest. The street railway which formerly gave a short distance urban service has found itself extended far into the country; the same car which disputes the passage of a busy city street with a truculent teamster, may, an hour later, be flushing partridges and grouse along the rural highway, stopping to leave the tired artisan at his country home, and bringing a healthful excursion within reach of the humblest family; thus the trolley car is rapidly filling a long felt want, which was neither within the power nor the disposition of the great steam railroads to supply. All this means changed conditions with new responsibilities, and emphasizes the need of consolidation.

To successfully amalgamate such properties and organize and operate them with due economy and a just regard for the needs of the communities to be served, requires of the operating officials a high degree of experience and skill. The new problems to be met offer better positions to which those who are ambitious may aspire, and the wonderful rapidity with which this situation has been developed, will be a lasting monument to the officials of our American street railways. The advantages of this larger growth are many and perhaps not the least is a growing respect for the value and importance of the street railway industry, which we may all hope will ere long be recognized by just laws which shall deal fairly and equitably with the relations of the street railways to the municipalities, and give to capital invested in urban and suburban transportation, security and a fair return upon the investment.

### REPORT OF THE SECRETARY AND TREASURER.

The statement of the finances of the Association showed cash on hand Aug. 25, 1898, as $3,656.28, and the receipts to Oct. 11, 1899, as $7,650.87, of which $450 was for membership fees, $3,930.67 for dues, $3,137.70 for space at the Boston convention and $132.50 for space at the Chicago convention. The total expenses to Oct. 11, 1899, were $5,648.28, leaving a balance of $5,658.87.

Aug. 25, 1898, there were 173 members; to Oct. 11, 1899, 7 new members had joined and 8 had withdrawn, making the membership at that date 172.

### MR. YERKES' PAPER.

The only paper of Tuesday's proceedings was one entitled "Investments in Street Railways; How Can They Be Made Secure and Remunerative?" which was read by Charles T. Yerkes, President of the Chicago Consolidated Traction Company and of the Union Elevated Railroad Company. Mr. Yerkes traced the history of the development of street railways from the day of the bob-tailed one-horse car on the strap-rail single track to the present day of many-tonned luxurious double-truck electric cars on road beds comparable in weight and strength with the foundations of fair sized buildings. Mr. Yerkes' chief argument was for a more settled policy on the part of municipalities toward the street railway corporations and offered suggestions for a solution of this problem fair to both sides. To quote from the paper: "Every State wherein there are large cities, which necessarily have important street railways, should have a commission appointed to ascertain the condition and requirements of this industry. The commission should be appointed by the Governor of the State and should be composed of intelligent business men of first class standing who are not interested in street railways. Under no condition should a person holding office, or who is ambitious to do so, be named. A man of this character is never to be trusted in any affair where courageous opinions are expected. The reports of such a committee should have great weight with the legislators.

"I believe that all corporations which receive their life from the commonwealth should be subservient to that commonwealth. That there is nothing in their formation or general business which should not be reported to the proper authorities and be subject to investigation. I believe that the law should provide that an intelligent commission be appointed by the Governor of the State in the same manner as is now done in this State, in regard to the commissioners of the park system. The duties of this commission would be to see that the laws concerning street railways are carried out and that the companies have the protection to which they are by law entitled. The commissioners should have terms of 15 years, so as to insure their becoming experts, and receive such salaries as would enable them to live well and take care of their families in a good manner. They should understand, when appointed, something of the street railway business, and as the years pass by their knowledge should increase, as also their worth. They should have the power to dictate to the railway companies where new roads should be laid, if at all, and also the kind of new improvements to be used when a railroad contemplated making any change in motive power. They should have the power to regulate the devices to be used for saving life and preventing accidents. With an intelligent, honest commission of that kind street railway managers would be made more comfortable, the people would

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be benefited and the securities of the corporation would be more solid. The advice of the commissioners would be sought, and the advice of such men, with the experience and knowledge they would naturally have, would be most valuable to any railway manager. Their reports would be explanatory, and much of the ignorance regarding street railways which is fostered by our enemies, particularly in this part of the country, would be done away with."

In the discussion which followed Col. N. H. Heft made a statement that is of interest to engineers, as follows: "While I believe that it is necessary to look after your municipalities, your Legislature and your representatives in general, yet I believe that the greatest benefits that will come to the street railway investment will be through the mechanical and electrical engineers in improving the present equipment of the railroad. I believe that our attention has never been sufficiently called to this matter, and that in a great many cases we have suffered from this lack of attention to the question of car equipment and to the weights that we are hauling to-day. We haul one passenger for whom we receive five cents, and for whom we are compelled to stop our cars twice, to take him on and to let him off. In going over the question of weights that we are drawing to-day, I was simply horrified to find that for every passenger we were hauling 720 pounds of dead weight, where the steam railroads are hauling 137 pounds with their standard system of railroad equipment. Now, I think that it behooves the street railroad managers to turn their attention to the question of equipment to see if we cannot get rid of some of this weight, and we expect to produce within the next two months a car, including the entire equipment, that will not exceed 227 pounds per passenger."

Wednesday morning a paper was read by Mr. J. H. Vanderveer, Superintendent of the shops of the Brooklyn Rapid Transit Company, on the "Care of Car Equipment," part of which read as follows:

"In the maintenance of motor equipments to-day, where almost continuous service is demanded and high mileage made, only those equipments fitted with both oil and grease boxes will safely run over 40 days without a thorough overhauling. To do this overhauling a large road will be obliged to do it at a number of different points. To overhaul a motor car thoroughly it is advisable to have at each overhauling shop extra trucks with motors mounted and all in first class order ready to run under a car body whose trucks and motors need overhauling. To properly lift the body from the trucks four duplex chain hoists, or air hoists, conveniently located, together with two cross timbers and four stirrup irons, form as good a combination as can be found, and will do the work with the least possible injury to the car body. When the body is lifted the truck to be overhauled is run out and the good truck substituted, the car lowered, connected up and turned over to the operating department. The whole operation taking about one hour, and for that length of time only is the use of the car body lost. For convenience in overhauling, a suitable crane, properly located, equipped with a carriage and another duplex or air hoist, will be found of great convenience. Such a crane can be readily made in any blacksmith shop and for the arm a piece of old rail can be used. When the motor is opened the armature should be lifted out and placed on a suitable rack, where the commutator can be cleaned and the armature tested for insulation. The fields should also be tested for drop, and where there is a drop those fields and armatures should be used in motors by themselves, keeping new and rewound fields and armatures in motors by themselves. This prolongs the life of the equipment and reduces the number of crippled cars taken off the road. The motor shell should be thoroughly cleaned out, either by compressed air or by washing with kerosene. The grease in the grease boxes should be taken out and put in a gear case and the grease boxes thoroughly washed out with kerosene. Brush holders should be taken out and thoroughly inspected and cleaned. At the same time is the best opportunity for truck inspection. The writer has found that all overhauling done with the car standing over the pits, the bottom half of motor dropped, does not allow the thorough overhauling necessary to keep the motor equipment in the shape it should be kept, besides tying up a complete equipment while such overhauling is being done."

At the meeting on Thursday a paper was read by Mr. Edward Butts, Chief Engineer of the Metropolitan Street Railway Company of Kansas City, Missouri, on the "Construction and Maintenance of Street Railway Tracks." The paper was not, as its title indicates, a general description of this subject, but described in detail one style of truck construction in which the rails are bedded in heavy concrete stringers and the joints are cast-welded. Following the discussion on this paper the report of the nominating committee was read. The committee recommended Kansas City as the next place of meeting and the following gentlemen for officers of the Association for the ensuing year:

President—John M. Roche, General Manager Chicago Union Traction Company, Chicago, Ill.

First Vice-President—John A. Riggs, President United Traction Company, Reading, Pa.

Second Vice-President—H. H. Vreeland, President Metropolitan Street Railway Company, New York City.

Third Vice-President—F. G. Jones, Vice-President Memphis Street Railway Company, Memphis, Tenn.

Secretary and Treasurer—T. C. Penington, Treasurer Chicago City Railway Company, Chicago, Ill.

Executive Committee—The President, the Vice-Presidents and C. S. Sergeant, Second Vice-President Boston Elevated Railway Company; C. K. Durbin, General Superintendent Denver Consolidated Tramway Company; Nicholas S. Hill, Jr., General Manager Charleston Consolidated Gas & Electric Company; Charles W. Wasson, Vice-President Akron, Bedford & Cleveland Railroad Company; John R. Graham, President Quincy & Boston Street Railway Company.

After the election of these officers a paper was read by Mr. Ira A. McCormack, General Superintendent of the Brooklyn Heights Railroad Company on "Train Service and Its Practical Application," a subject not of particular interest to the majority of readers of this paper.

Over 300 members of the Association and friends attended the banquet in the auditorium. The toastmaster of the evening was C. S. Sergeant, the retiring president. One feature of the banquet was the installation of the new officers.

## THE LINE LOSSES OF POLYPHASE TRANSMISSION.

BY GEORGE T. HANCHETT.

At various irregular intervals there appear in the columns of the technical press and elsewhere tables of the relative amounts of copper required by different systems for the transmission of equal amounts of power over a given distance at equal voltage and with equal economy.

The tables advanced by conceded authorities differ widely and are hence very confusing to the student who happens to notice the disparity, and in the absence of definite information as to how the results are obtained he is likely to charge one or the other of his sources of information with a blunder or to conclude that the necessary copper to transmit polyphase power is a mysterious variable, to be classed in the same category as the impedance and the power factor of circuits and capable only of approximate prediction.

As a matter of fact the necessary copper for a polyphase transmission is capable of just as accurate calculation as parallel cases in direct currents, and the only reason that authorities differ is because they consider the problem from different points of view. As will be seen later in this article, equal voltage, an unquestionably definite expression in the case of direct and single-phase alternating transmission, may in polyphase transmission refer to one of several voltages, all of which exist in the same line. For instance, we may compare the single-phase system with the Y connected three-phase system shown in Fig. 1, the common junction being connected to earth, as is frequently done for purposes of regulation.

If we compute the necessary copper on the basis that the voltage between A and O be equal to that of the single phase with which comparison is to be made, a totally different result will obtain from that which would follow from assuming the voltage between the corners of the

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triangle to be equal to the single-phase pressure; and, point of view considered, either result is correct.

This article is therefore an attempt to reconcile these varying results and show how each of them is obtained. As a preliminary we will suppose that a certain power W is to be transmitted a distance D at a voltage V and that the loss in a single line be w.

Let us assume the following letters of reference:

V = voltage of system.

W = watts transmitted.

D = distance transmitted.

c = current in a line of single-phase system of reference.

$c_1$ = current per line of polyphase system.

v = drop in a line of single-phase system of reference.

$v_1$ = drop in a line of polyphase system.

K = resistance of line of unit area and length D.

w = watts lost in one line of single phase system of reference.

$w_1$ = watts lost in one line of polyphase system.

With the single-phase system, see Fig. 2, it is plain that $w = v\,c$ where v is the volts lost in one line and c is the current in the system.

This we will retain as a standard of reference. It is evident that the necessary copper will consist of two lines of length D and resistance $\frac{v}{c}$. The sectional area of this copper is inversely proportional to its resistance and may be represented by

$$\frac{c\,K}{v}$$

where K is the resistance of unit area of length D. The total volume of the copper will then be

$$\frac{2c\,K\,D}{v} \qquad (1.)$$

which for convenient comparison with other values to be deduced we may call 100.

Let us now consider that we are to transmit the same power by means of a four-wire two-phase system with independent circuits, as shown in Fig. 3.

It needs no demonstration to see that it is a case of simply transmitting half the current over each of two single-phase circuits and that there will be necessary four lines of double the resistance of those of Fig. 2. There is, therefore, no saving of copper in this case, indeed the four-wire line is more expensive to construct than that using the two wires.

If we use the star system shown in Fig. 4 there will be no gain, for if the phases are balanced the system will behave exactly as one of independent circuits, and if unbalancing occurs, the amount must be specified before the economy of the line can be fixed. All this presupposes that the opposite terminals of the two-phase windings are producing the same pressure as the single-phase system with which they are compared.

Where the power is generated or received in a mesh system, as shown in Fig. 5, the voltage between

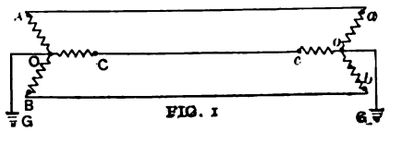


FIG. 1

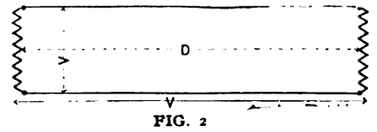
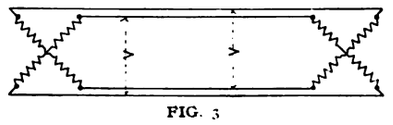
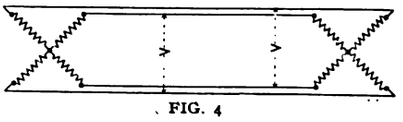


FIG. 2


FIG. 3


FIG. 4

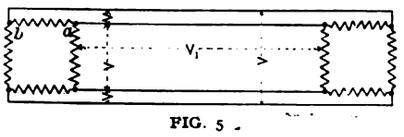


FIG. 5

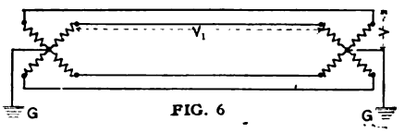


FIG. 6

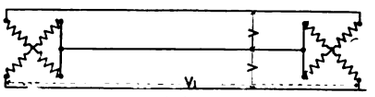
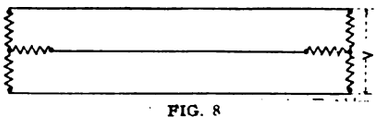
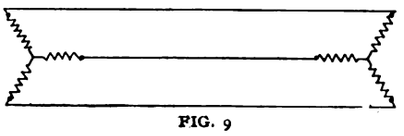
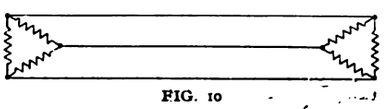


FIG. 7


FIG. 8


FIG. 9


FIG. 10

adjacent phases a and b is often considered to be the voltage of the system. If this is made equal to V there appears a decided saving in favor of the two-phase system. In this case the total energy transmitted is evidently 4CV where C is the current in one of the legs of the mesh, and at equal W, therefore, equal to one-fourth of the current in the single-phase system of reference. The current in one of the lines $c_1 = C\sqrt{2}$ and if the systems are to be of equal efficiency we have $4v_1c_1 = 2vc$, and as $C = \frac{c}{4}$ we easily deduce $v_1 = v\sqrt{2}$.

It follows therefore that the area of a single transmitting wire is

$$\frac{K\,c}{4v}$$

and the total volume of four such lines

$$\frac{K\,c\,D}{v}$$

or 50% of the copper necessary in single phase work.

The two phase system may be connected up star fashion with the common center earthed for purposes of regulation, as shown in Fig. 6.

If the load be composed of lamps, the voltage between one leg and the ground has sometimes been assumed to be the voltage of the system. A deduction will readily show that in such a case that the total copper equals

$$\frac{D\,K\,c}{2\,v}$$

or 25% the copper necessary for a single phase system.

Another case of two phase transmission, shown in Fig. 7, offers two more values:

If the voltage of the system is considered that between either line and the common return, the total power transmitted is $2Vc_1$ where $c_1$ is the current in the outer lines and is therefore equal to $\frac{c}{2}$. The current in the common return is not $2c_1$, but $c_1\sqrt{2}$, and if the loss of pressure in each wire is $v_1$, we have

$$2v_1\,c_1 + v_1\,c_1\sqrt{2} = 2\,v\,c$$
$$v_1 = 1.1715v.$$

The resistance of each of the outside wires is

$$\frac{2{,}3432v}{c}$$

The total volume $= \frac{2\,K\,c\,D}{2{,}3432v}$

and the volume of the common return is

$$\frac{D\,K\,c}{1.1715\,v\sqrt{2}}$$

making the grand total volume of copper

$$\frac{1.456\,D\,K\,C}{V}$$

or 72.8% of the copper used in an equivalent single-phase transmission.

If the voltage between the two outside lines is considered the basis of compari-

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son and made equal to V, the voltage in a single coil of the system will be equal to $\frac{V}{\sqrt{2}}$, and if $c_1$ is the current in each of the two outer legs of the system, the total power will be $\frac{2 c_1 V}{\sqrt{2}} = c_1 V \sqrt{2}$, and placing this quantity equal to cV, we may obtain

$$c_1 = \frac{c}{\sqrt{2}}.$$

The current in the common return is $c_1\sqrt{2}$, or in this case c. If $v_1$ be the drop in the lines it follows, if the line losses are to be equated with reference to those of an equivalent single phase system, that

$$v_1 c + 2v_1\frac{c}{\sqrt{2}} = 2v c$$

whence

$$v = 8284\ v.$$

The volume of the outer wires is

$$\frac{2 D K c}{.8284\ v \sqrt{2}}$$

and the volume of the common return is

$$\frac{D K c}{.8284\ v}$$

The total copper equals

$$\frac{2.914\ D K C}{V}$$

or 145.7 of the copper necessary in a single phase system.

The monocyclic system, Fig. 8, is a variety of three phase system, the one phase being used for starting motors and then ceasing to act, uses the same amount of copper as a single phase system, plus whatever is necessary for the auxiliary circuit. The proper amount of this auxiliary copper does not depend upon any definite law, but depends upon the judgment of the constructing engineer, in much the same way as the neutral of a three wire direct current system is dimensioned from practical consideration.

The three phase systems are capable of analagous demonstrations to the foregoing performed in a similar way.

Perhaps the most common of these is the Y system shown in Fig. 9. The voltage between any two legs of the Y is usually taken as V the voltage of the system. The voltage of any one coil is equal to

$\frac{V}{\sqrt{3}}$ and the total energy $V\ c_1\sqrt{3}$ and placing this equal to Vc we find $c = c_1\sqrt{3}$

The power lost is $3\ v_1\ c_1 = v_1 c \sqrt{3} = 2\ v\ c$

hence $v_1 = \frac{2\ v}{\sqrt{3}}$.

The resistance of one line is therefore $\frac{2\ v}{c}$ and the total volume of copper becomes $\frac{3\ D K c}{2\ v}$

or 75% of the copper in an equivalent single phase system. This system is perhaps the most popular of all transmission systems and a convenient rule suggests itself in this connection. It is as follows: To calculate the proper size of wire for a three phase transmission, calculate as for a direct current transmission of the same length, voltage and economy. Divide the area of the wire thus found by two and the result will be the proper size of each of the three wires to be used in the three phase system. This rule puts the calculation within the reach of a wireman with a direct current education.

If the system has a grounded common junction, as shown in Fig. 1, the voltage of reference is sometimes taken as that existing between any wire and the earth, and the copper economy appears even better. The total transmitted energy is $3\ V\ c_1$ from which it is easy to see that $c_1 = \frac{c}{3}$. The power lost equals $3\ v_1 c_1 = v_1 c$, and placing this value equal to the power lost in single phase work we have $v_1 c = 2\ v\ c$ whence $v_1 = 2v$.

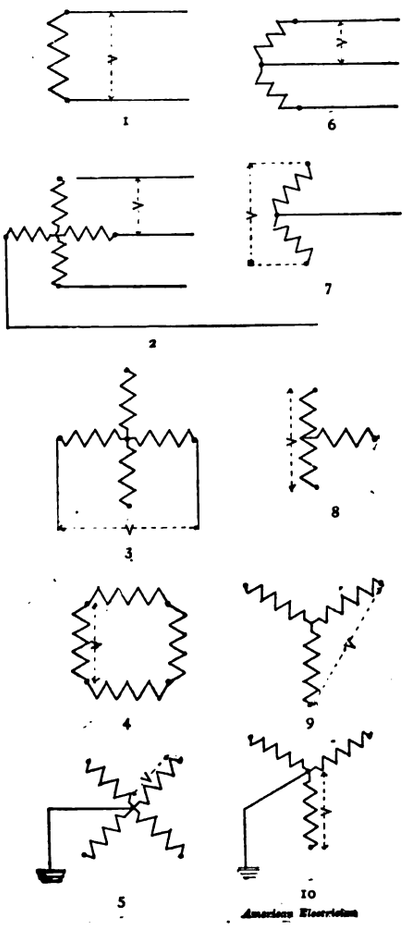



FIG. 10.

The resistance of each line is then $\frac{6\ v}{c}$ and the total copper is $\frac{K D c}{2\ v}$

or 25% of the copper necessary in single phase work.

In the mesh combination the same result as with the Y system obtains. The diagram is shown in Fig. 10.

The voltage of reference V can obviously be none other than the voltage between any two corners of the mesh. The total power transmitted is $V\ c_1\sqrt{3}$ for the current in one of the branches of the mesh is $\frac{c_1}{\sqrt{3}}$ where $c_1$ is the current in the line. Equating this value to the single phase power we obtain

$$Vc_1\sqrt{3} = Vc$$

whence $c_1 = \frac{c}{\sqrt{3}}$

The power lost $3v_1c_1 = 2\ v\ c$

whence $v_1 = \frac{2\ v}{\sqrt{3}}$.

The resistance of a line equals $\frac{2\ v}{c}$, and the total volume of copper $\frac{3\ D\ K\ c}{2\ v}$ as before.

In closing this article a recapitulation of these results and a few words of comment will be appropriate.

| | | Copper. |
|---|---|---|
| 1. | single phase. . . . . | 100 |
| 2. | two-phase independent . . | 100 |
| 3. | two-phase Y balanced. . . | 100 |
| 4. | two-phase mesh balanced . | 50 |
| 5. | two-phase y center to earth | 25 |
| 6. | two-phase three wire . . . | 72.6 |
| 7. | two-phase three wire . . . | 145.6 |
| 8. | monocyclic . . . | 100 + auxiliary |
| 9. | three-phase Y. . . . . | 75 |
| 10. | three-phase y comm n junction grounded . . . . . | 25 |
| 11. | three-phase mesh. . . . . | 75 |

It is manifestly unfair to make comparison between single and polyphase transmissions using any but the highest voltage of the polyphase system, but it has been done and has misled many. The machine and the line has to be insulated for the higher voltage and should be so rated. Results 1, 2, 3, 7, 8, 9 and 11 are in the writer's opinion the only ones that are honestly comparable.

It will be also noted that the drop $v_1$ in many of the polyphase systems was greater or less than v, the drop in the single phase system. The above demonstrations assumed equal line loss in watts, which is the more important in long distance work. In local distribution for lighting purposes the systems have been compared for equal line losses in volts, which give still different ratios of copper economy.

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# Some Recent Electrical Patents.

**A Means for Starting Arc Lamps on Constant-Potential Circuits**—At the instant of closing the circuit of an arc lamp across constant-potential mains the carbons are together and the full voltage is

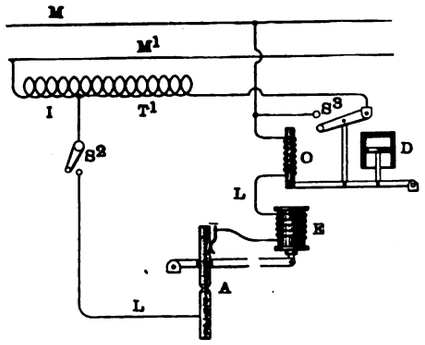



FIG 1.—A STARTING DEVICE FOR ARC LAMPS.

resisted only by the series resistance and solenoid, causing a great rush of current. This draws the carbons so violently and suddenly apart that the carbon vapors, upon whose existence the arc is dependent, do not have time to form and the arc is broken. This interrupts the circuit and the carbons coming together again the action is repeated, causing chattering. This has been reduced in the past in several ways. One is by the use of soft-cored carbons which give off their vapors more quickly but which are expensive and short-lived. Another method is to use a dash-pot to restrain the sudden movement of the controlling magnet, but this very restraint necessitates the flow of an excessive current until the dash-pot is overcome. Still another method is the use of a series resistance considerably greater than that necessary for smooth running, but this is of course wasteful. Messrs. H. A. Wagner and D. W. Roper of the Missouri-Edison Company, St. Louis, offer another means of overcoming this disadvantage which consists in starting the circuit with a reduced current, sufficient to heat the carbon tips to redness but insufficient to act upon the series magnet and strike the arc. In a patent recently issued they broadly claim this method and describe various means of accomplishing it, one of which for alternating-current work is illustrated diagrammatically in Fig 1. Here M and $M^1$ are a. c. low-voltage mains supplying the arc shown at A, through an auto-transformer or economy coil $T^1$ for reducing the voltage. The apparatus is shown in the open-circuit position. To start the lamp the switch $S^3$ is closed, giving a circuit through a part, I, of the economy coil, the switch, $S^3$, the wire, L, the arc, A, the series magnet, E, and the solenoid, O. The right-hand coil of the auto-transformer is on open circuit so that the left end section which is in series with the arc acts as an inductive choking coil, reducing the current to a value insufficient to energize the magnet, E, but sufficient to heat the tips of the carbons. This current is also sufficient to energize the magnet, O, which closes the switch, $S^3$, slowly on account of the dash-pot, D. When the switch, $S^3$, is closed the winding, I, is instantly transformed from a choke coil to one side of a constant-potential auto-transformer or compensator, giving the lamp sufficient current to strike the arc. On account of the previous heating the carbon vapors are instantly thrown off and the arc burns without chattering. Patent No. 631,975.

**A Laminated-Contact Switch.**—Switche of the ordinary knife and jaw type, used for the enormous currents generated by low-tension machines of several hundred or thousand kilowatts capacity become of unwieldy proportions in order to provide sufficient area of contact as well as to dissipate the power wasted within them with-

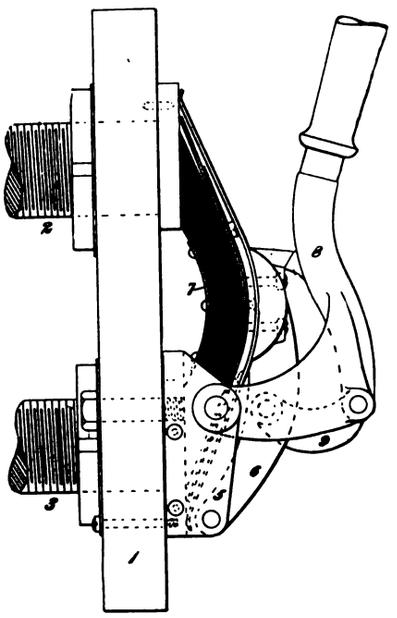


FIG. 2.—A LAMINATED CONTACT SWITCH.

out overheating. Owing to the friction due to the binding of the knives in the jaws upon which they depend for good contact their operation becomes quite too difficult for hand work. On this account many makers are adopting a contact made up of the ends of many laminated leaves of spring-tempered copper bearing upon solid copper blocks, a type of contact quite generally used in England, but hitherto little used in this country except in the main contacts of the General Electric Company's circuit breakers. The Westinghouse Company has adopted this type of contact for its pneumatically operated circuit breakers and throw-over switches for large railway generators and a patent recently issued to G. Wright and C. Aalborg describes the construction of the same type of switch as designed for hand operation. A side elevation of the switch is given in Fig. 2, which may be briefly explained as follows: The base or switchboard panel is shown at 1 and through it pass the contact studs, 2 and 3, ending respectively in bearing plates against which press the ends of the laminated contacts, 7. These are held at their middle point in a clamp which is attached to a link, 6, pivoted to the lower terminal, at 5. To the link, 6, is also pivoted another link, 9, which connects with the handle, 8. This when thrown up locks the laminated contact in the closed position by means of a toggle joint, and when thrown down opens the circuit by lifting the laminations directly away from the contact plates. Patent No. 633,771.

**Combined Telegraph and Telephone.**—For some purposes, such as train dispatching, the telephone is on account of its speed superior to the telegraph, but inaccuracies are apt to creep in, especially in the transmission of numbers or names. To obtain the speed of the one method of transmission for the greater part of a message and the accuracy of the other for the transmission of numbers, names or other important or difficult words, Mr. R. M. Bailey has patented the combination of a telephone and telegraph in the manner described below. Fig. 3 shows a sketch of the arrangement indicating a transmitter of the usual granular form connected as usual in a local battery and microphone circuit. Mounted on an extension of the transmitter-holding arm is the sounder of a local telegraph circuit. The sounder is operated in the usual way by means of a key and battery. The transmission of the telegraph message to the distant receiver is accomplished solely through the vibration set up by the sounder in the transmitter arm, and the consequent noise set up by the microphonic transmitter in the telephone circuit. In using the instrument one would talk as usual until a name or number or other word difficult to make clear arose, this word being tapped off on the key. Patent No. 630,841.

**A Single-Phase Induction-Motor Starting Device.**—As is well-known simple single-phase induction motors without com-

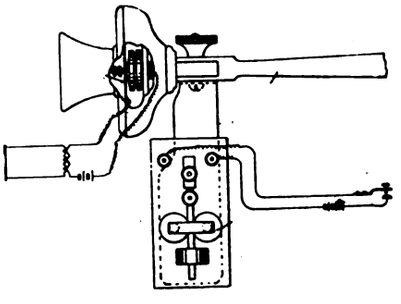


FIG. 3.—A COMBINED TELEGRAPH AND TELEPHONE.

mutators or auxiliary short-circuited or acceleration coils have no tendency to turn in either direction when their rotating parts are at standstill. If, however, the rotor is given a turn by hand in either direction and is disengaged from

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the load it will continue to turn in the same direction and gradually run up to full speed, after which it will exert its full power practically as well as does a polyphase induction motor. Like the polyphase induction motor, also the torque which it will exert when first started off by hand can be greatly increased by inserting resistances in the circuits of the secondary or rotating windings instead of leaving them short-circuited as they should be when the motor is running at full speed. If the coils of the secondary or rotating member of a single-phase motor are fitted with collector rings connected to external resistances of the proper value the slightest turn given the secondary will serve to start it off. For large motors, however, of 100 h. p. or more, it is difficult to give this turn by hand, and Prof. Riccardo Arno, the well-known Italian scientist, has patented a means of giving this slight turn electrically. The secondary of such a motor should have three collector rings connected at equal intervals to the secondary winding, and Prof. Arno's method consists in open-circuiting for a brief instant in starting the line from one of these collector rings. This gives an unbalanced torque on the repulsion principle to the secondary circuit, which tends to set itself so that the alternating field from the primary shall thread through the open-circuited section of the secondary instead of the short-circuited section. This tendency gives the rotor a part of a turn and by properly closing the remaining secondary connection the motion thus started will be maintained and the motor will run up to speed. Patent No. 631,919.

**A Means of Reducing Sparking at the Contacts of Circuits Including Magnets.**—The fact has long been recognized, and has been mentioned in some works on telegraphy, that the sparking at the contacts of a local telegraph circuit can be reduced by winding the magnet with two wires connected in parallel with each other. That is to say, if the coil of a magnet, instead of being wound with one wire of the proper cross section, is wound with two wires of half that cross section and the

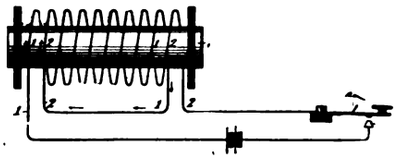


FIG. 4.—AN ANTI-SPARKING WINDING FOR MAGNETS.

same number of turns, these two windings being connected in parallel and giving the same magnetizing effect with a given current as does the single winding, then the sparking will be less. Messrs. Chas. L. Buckingham and Emil Germann, in their experiments with high-speed printing telegraphy, have discovered that a magnet wound with two wires on the duplex principle, i. e., the two wires lying side by side throughout their length, these two wires being connected in series, gives less sparking effect than does the same magnet wound in the ordinary way with the same size of wire and the same number of turns. In fact, they claim that by this means "the spark at points of rupture may be almost wholly eliminated." The action is probably due to a condenser action between adjacent turns having considerable difference of potential, the electrostatic charges from which balance to a certain extent the self-induction. The inventors claim broadly this method of winding magnets for the purpose of protecting contacts against destructive sparking. It is possible that the same method may be used in alternating-current apparatus to reduce somewhat the self-induction, its use in this way being outside of the claims of the patent No. 634,198.

**The Construction of Fly-Wheel Alternators.**—In dynamo machines of the rotating-field type there is a tremendous outward pull of the poles, made up in part of the centrifugal force, and in part of the attraction of the pole pieces for the external armature. To fasten laminated poles securely against this force and still

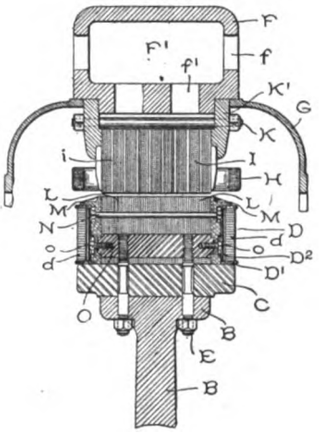



FIG. 5.—SECTION OF FLYWHEEL ALTERNATOR.

make them readily removable for repairs without dismantling the whole machine is no easy problem. In small machines the laminations are dove-tailed into the hub or yoke supporting them, but in large machines of the fly-wheel type the yoke upon which the field pieces are mounted becomes a large ring, the dove-tailing of which would be an expensive process and would weaken the ring which must stand considerable rim tension. The General Electric Company in such machines punches a large hole through the field laminations and passes through this hole a heavy bar, which is then securely bolted to the yoke. The arrangement is patented by Mr. H. G. Reist and is shown in Fig. 5, which is a longitudinal section through a field pole and the armature of such a machine. B is one arm of the spider driving the rim, C, to which is attached a pole, D. This is made up of the usual laminations, LL, forced together by means of the bolt, N, and through which passes the steel bar, O. This bar has a shoulder at each end, against which the end plates, MM, are seated and bolted by means of the bolts, oo. The field pole is fastened in place on the rim of the fly wheel by screwing the bolts, E, into the bar, O. In this case the same bolts serve also to fasten the fly wheel rim to the spider. The field winding is of the edgewise type, shown at d, consisting of a copper ribbon laid up on edge around the pole. The construction of the armature is indicated in the upper portion of the figure, in which I is the armature-iron, held in place by the bolts K between the end rings K'. Guards, G, protect the coils, H, against accidental injury. The sustaining structure, F, of the armature is cast with a hollow body, F', into which lead openings, f. Other openings, f', allow free circulation of air

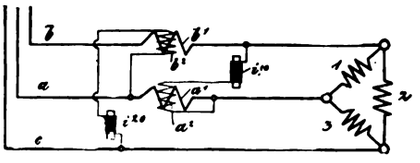



FIG. 6.—CIRCUITS OF MOTOR METER.

around the armature-iron, the usual spaces, i, being left between the groups of laminæ by the insertion of the now well-known space-blocks. Patent No. 630,409.

**A Three-Phase Motor Meter.**—In alternating current meters of the induction type it is necessary to obtain a lag of the current in the potential or shunt winding 90° behind the impressed e.m.f. to give accurate indications on inductive loads. The lagging shunt current is then made to excite one pole or set of pole pieces and the series current is led around another set, these two sets of poles acting together on a short-circuited secondary to give a split-phase induction-motor action. In three-phase feeders or mains the current passing through any wire is not in phase with the difference of potential between any two wires, and it is impossible to get a difference in potential from which to obtain the proper lag of 90° without the use of the Y-box or some equivalent arrangement. Mr. G. Hummel has conceived the simple idea of taking the differences of potential as he finds them and setting up a lag in each shunt circuit of 30° behind the impressed e.m.f., thereby obtaining the desired 90° behind non-inductive current in the series circuit, instead of going to the trouble of using a Y-box in order to obtain an e.m.f. in phase with the current in the incoming wire and then causing a lag of 90° behind the e.m.f. The arrangement is shown in the accompanying diagram, Fig. 6, in which a b c are the incoming leads carrying current to the delta-wound machine, 1, 2, 3, this current being measured on the two-wattmeter method. Considering the meter motor containing the series coil, $a^1$, connected in the lag, a, its shunt coil, $a^2$, is connected in series with the impedance coil, $i^{10}$, between the legs, a, and b, of the circuit. The impressed e.m.f. between these two legs is 60° behind the current through leg, a, when the load is non-inductive, and a further lag of 30° is easily obtained by means of the induction coil, $i^{10}$. In the same way the other meter motor, $b^1$ and $b^2$, is connected into another phase. Patent No. 633,695.

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# NOTES.

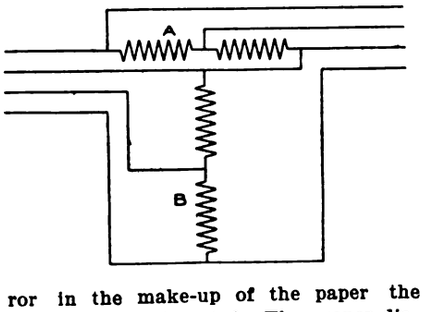
**The Largest Gas Engine** in the world is one now being made by the Westinghouse Machine Company at the works in East Pittsburgh. The engine will be rated at 1500 h. p. Its cylinders are 34x60 inches in dimensions, its extreme length 44 feet, width 12 feet 4 inches, and height over all 27 feet.

**Street Railway Exhibition to be Held in London.**—The proprietors of the "Tramway and Railway World" have arranged for an international tramways and light railways exhibition, the first of its kind in Europe, which will be held at Agricultural Hall, London, from June 30th to July 11th, 1900.

**Castings for the Single-Phase Rectifier.**—Mr. W. F. Brown of So. Norridgewock, Maine, announces that he has patterns for the rectifier described in the June issue of the American Electrician and will be able to supply castings at a reasonable price. He will not be able to supply armature punchings.

**The New Ownership of the Chicago Edison Company.**—The Chicago Edison and Commonwealth Electric properties of Chicago have been transferred to a new company which is practically the Whitney-Widener-Elkins syndicate, which already owns extensive traction interests in Chicago and lighting and traction interests in New York and other cities. The new company will have a capital stock of $25,000,000, and be bonded for the same amount. Edison stockholders will get $2.00 for $1.00 of par valuation of their old stock in the 4 per cent bonds of the new company and a bonus of 50 per cent in the new stock.

**A Simple Two-Phase System of Secondary Mains**—In the last issue of the American Electrician, page 473, a note appeared under the title given above illustrated by a diagram for which by an unfortunate error in the make-up of the paper the wrong cut was inserted. The proper diagram showing the system of secondary mains is given herewith. As explained in greater detail last month, four wires carry one phase on the three-wire system to lamps and both phases to motors.




**An Electrically Operated Dry-Dock Equipment.**—At the League Island Navy Yard of the United States Government there is to be constructed for the use of the Navy a large timber dry dock, the entire pumping and other power equipment of which will be run by electric motors supplied by an isolated plant to be especially installed for the purpose. The generating plant will consist of two vertical cross-compound engines, each coupled to two 250-kw., 125-volt dynamos, constituting two three-wire sets. The largest motors will be three of 450 h. p. each, direct connected to the runner shafts of the main pumps. There will also be 8 capstans and 3 winches, each driven by a motor of not less than 35 h. p., besides several other auxiliary motor-driven machines.

**An Odd Form of Bridge.**—At Rouen, France, there is in service a bridge the highway of which consists of a hanging platform which moves from side to side of the river. The bridge proper is of the suspension type, 160 ft. above the water level, and carries a track on which runs a trolley, from which is suspended a platform at the street level. This platform travels from side to side of the river, accommodating passengers and vehicles. This odd arrangement, resembling in some respects a ferry boat and in other respects a bridge crane, is driven by two electric motors mounted on the traveling platform and transmitting their power to the wheels of the trolley overhead by means of a rope drive. The platform has an area of 35x40 ft. and weighs 20 metric tons, the total moving weight of trolley, cables, platform and live load being over 100 metric tons.

**A Peculiar Central Station Accident.**—At 3 o'clock in the afternoon of October 18th a large water tank, holding 50,000 gallons of water, burst, and crashed through the roof of the power house of the Ocean City Electric Light Company at Ocean City, N. J. The water tank stood on a framework 50 feet high, immediately adjacent to the power house. Its fall wrecked the plant, breaking the steam pipe flanges and flooded the generators. Fortunately only one man was injured by the accident. A few minutes after the crash Superintendent H. M. Kalbach started running a temporary steam connection, and in three hours and 25 minutes the water works pump and the incandescent service were in operation, and the following evening the center of the town was again lighted with arcs. In spite of the fact that the water had to be pumped out of the power house, the dynamos being deluged and soaked, Superintendent Kalbach reports that they worked splendidly and gave no trouble whatever.

**The Electrical Distribution of a Time Standard.**—In a paper presented before the electrical section of the Franklin Institute, Mr. James Hamblet, manager of the telegraphic time service of the Western Union Telegraph Company, gave the following information about the telegraphic time systems in this country:

Previous to the adoption of a standard time, there were over 80 standards throughout the United States. In the State of Ohio there were eight different standards. Now there is only one standard of time in the whole country, differing only by even hours; and the time is sent daily from Washington to the entire country, so that the whole question is simplified. The Western Union Telegraph Company distributes the time from Maine to California. In New York there are something like 1500 self-winding clocks, corrected every hour by the standard clock of New York. In New York City there are 23 circuits extending all over the city from Western Union Building, 195 Broadway. The standard clock sends out its beats over the city every two seconds, beating the even seconds, zero, 2, 4, etc., omitting the 58th second every minute, thus making a pause at the beginning of each minute. Every fifth minute 20 seconds are omitted. Many of the prominent jewelers (nearly 200 in number) have sounders which tick every two seconds. The clock acts upon the 23 circuits by means of 23 relays, located near the clock in the time service room, and at each hour the standard clock sends a strong synchronizing current to the whole 1500 clocks in the city.

**A Comprehensive Tunnel Plan Proposed for Chicago.**—An ordinance has been introduced in the Chicago Common Council which grants permission to the Chicago Subway, Arcade and Traction Company to build and operate a comprehensive system of subways beneath the surfaces of the streets, decidedly in advance of the present needs, but laid out in an evident appreciation of the demands of great cities, perhaps 100 years hence. The ordinance gives power to construct, maintain and operate in the city of Chicago for a period of 94 years a system of subterranean ways, arcades, tunnels and conduits under all streets, avenues, parks, rivers, etc., to operate street railway cars in said tunnels, and to lay water, drainage and gas pipes and electric wires. Permission is also included for building a terminal station under certain city property, for which the company is to pay an annual rent equal to 5 per cent. of the valuation of the land. The compensation for the right to build and operate the subway system is 2 per cent. per year of the gross receipts of the company. The ordinance also gives permission to build a system of sewers at a lower level than the present sewers of the city, and to collect sewage and garbage in the district occupied by the system of the company; the sewage and garbage to be treated at reduction works to be operated by the company. All tunnels and arcades to be built are to be at least 18 feet in width and 13 feet in height. While this immediate move may be only a plan to obtain in advance and at no cost rights of great value, it indicates the originator's ideas of future urban needs.

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**The Electrical Application of Dental Anesthetics.**—Probably few electrical engineers, except those who have had considerable experience in the dentists' hands, realize how general is the use of electric current in the application of local anesthetics to the teeth. This function of the current is called by dental surgeons "cataphoresis," and is simply the forcing of anesthetic agents, such as cocaine, through the tissues of the tooth by means of a continuous current of electricity. The phenomenon is simply that known to physicists as electrical osmosis, by which a liquid is carried through porous walls or diaphragms when a current is transmitted through them. The temporary deadening of the sensitive nerves is the most important use of this application of the electric current. It has been found, however, that if the operation is prolonged the nerve is painlessly killed, giving a far more satisfactory method of accomplishing this result than the old slow and painful treatments. Experiment has shown that the pulp of the teeth can be anesthetized and extracted painlessly and immediately by "cataphoresis." A third use of the same application is the "bleaching," as it is called, of discolored teeth after the death and disintegration of the pulp. In this application a bleaching solution is used instead of anesthetics and the electrical current carries it into and disperses it more fully through the substance of the tooth than is possible by any other means so far discovered. Chemistry has not yet suggested a proper decoloring agent for the bleaching of teeth discolored by amalgam filling, though there is no doubt that when this is discovered the electric current will serve to carry it to the desired point. The "cataphoric outfit," as it is called, consists of a number of dry cells, an electrode to be applied to the teeth and a hand electrode for the other terminal, a rheostat for adjusting the current and a sensitive milli-ammeter for measuring it. Such outfits are now put on the market by the larger dental manufacturers.

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**A Two-Speed Induction Motor.**—As is well known, the alternating current induction motor runs most efficiently at speeds nearly synchronous with that of the rotating field set up within it, any considerable reduction of speed being accompanied by a corresponding waste of energy. An ingenious means of changing the speed of rotation of the field set up by currents of a given number of cycles has recently been incorporated by the General Electric Company in some large motors built for driving the grinding tables in a plate glass manufacturing establishment. The variation is accomplished by changing the connections of the windings of the motor by throwing over a switch, the result being a change of the speed of rotation in the ratio of 1 to 2, a ratio well suited to the needs of the machines driven, since they are often required to run at half speed. The general principle of the change is to double the number of poles for the lower speed and thereby cut in two the angular distance through which the rotary field passes during one alternation of the current. The special arrangement of the coils for this purpose is indicated in the partial development of the stator winding, Fig. 1, which shows two adjacent coils of one phase reduced to a unitooth representation. These coils are of fractional pitch for full speed of the motor, spanning a trifle over 50 per cent. of the distance between their centers. For full speed they are so connected that at any instant current passing through them will set up a north pole under one and a south pole under the other, the space between them being neutral. For half speed they are so connected that each one would tend at the same instant to set up the same polarity. If this is north there will be a south pole induced between them, thus doubling the number of poles of the machine and cutting in two the speed. The connection of the numerous coils of the three different phases in such a way as to most simply accomplish this change of circuits is indicated by the vectorial diagram given in Fig. 2. For running at full speed the windings are connected together on the usual star or Y system, and supplied through the three wires, 1, 2 and 3, the terminals, 4, 5 and 6, being on open circuit. For running at half speed the three wires, 1, 2 and 3, are short circuited to each other and the incoming power is brought through wires, 4, 5 and 6. It will be noted that between the legs, 4, 5 and 6, there is a small Y-connected winding, while the windings outside of this central Y constitute, through the short circuit mentioned above, another Y in parallel with the first. It will be also noted that at any instant under the latter connection current through a coil of the central Y flows in the reverse direction from that through the other coil of the same phase, while with the former connection for full speed the currents through the two are in the same direction, the same reversal taking place also in the other phases. The windings of one phase of every other pole around the machine are connected in one section, the intermediate poles being in the other. Thus the change of the circuits from 1, 2, 3 to 4, 5, 6, and the short circuiting of 1, 2, 3, reverses the alternate poles, as described above. It will be noted that with the low-speed connection there are half as many turns between terminals as with the high-speed connection, which would give a greater density at the lower speed but by connecting the coils to give half speed in series and full speed in parallel this condition can be reversed.

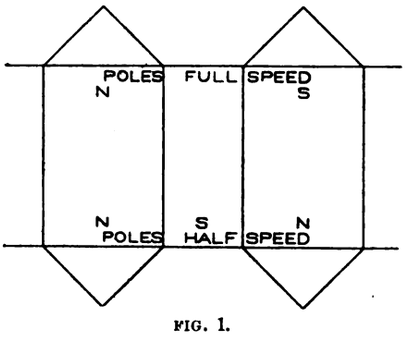



FIG. 1.

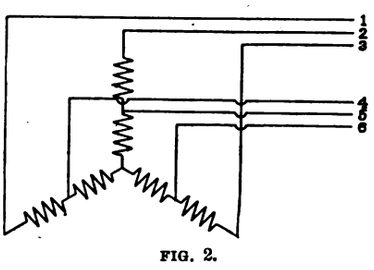



FIG. 2.

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**The Schlicht Process of Supplying Air to Furnaces.**—During the past year the Schlicht Combustion Process Company, New York City, has been exploiting and introducing a most remarkable and apparently paradoxical method of supplying air to furnaces.

By this new system the fresh air containing the oxygen for the fire is brought down through the stack and flue passages, the remarkable and apparently incomprehensible feature being the fact that the fresh air is brought through the same passage that conducts the waste gases upward and in immediate contact with these gases. The apparatus consists simply of a tube centrally inserted in the top of the stack in such a way that the products of combustion will pass out through it and there will be a draft of fresh air entering around it downwardly into the stack and escaping with the products of combustion up through the central tube. The claim is made that if the ash-pit doors are closed, or nearly closed, this fresh air entering around the outer edges of the stack opening, will pass down the whole length of the stack and find its way on through the breeching and the flues of the boiler—if the course is not too complicated—to the fire, the outer shell of fresh air flowing downward in the flues and stack remaining practically unmixed with the inner column of heated burned gases passing upwardly within it. Under such conditions the incoming air to the fire becomes heated on the regenerative principle and the claim is made that there is a great reduction of the excess oxygen and of unconsumed carbon monoxide below that found when the draft is drawn as usual through the grate bars. In cases where the passage of the gases is unusually tortuous, as where economizers are used, or several boilers discharge into one stack, the fresh air is not introduced at the top of the stack but is led in through an opening into the air passages at some point nearer the combustion chamber. The claim is made that in spite of the draft which would seem to draw the fresh air from such an opening straight toward the stack, the air will pass in the opposite direction toward the fire, will flow over and through the fuel and will then return upon its previous course, pass its point of entrance and escape through the stack.

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### The Various Means of Keeping Boilers Clean.

The steam boiler, so far as the materials entering and leaving it are concerned, is nothing more nor less than a mammoth still. All the water that enters it leaves it in the form of steam and if condensed becomes distilled water, chemically free from impurities. If the water that enters it contains any impurities whatever these must accumulate in the boiler and rapidly become concentrated to such an extent that they are deposited, eventually covering the boiler heating surfaces with a coating of solid matter or sludge, which seriously impairs the output of the boiler since this output is directly dependent upon the amount of heat that can be transmitted through the heating surfaces.

Many have been the methods and devices designed for purifying the water either before or after it enters the boilers, or for chemically acting upon the impurities so as to prevent their deposition and render them removable by blowing off. In surface condensing plants where the water from the hot well is returned to the boiler the same water circulates again and again through the system of boiler, engine and condenser. The only impurity that is introduced in this repeated circulation is the oil used for cylinder lubrication. Many arrangements are used for eliminating this, among them centrifugal oil separators in the exhaust steam piping and mechanical filters in the feed piping. A positive and simple remedy for the whole trouble of boiler impurities would be to use surface condensers and no cylinder lubrication, but steam engine practice appears to be hardly ready for this rather advanced remedy, although it may be forced upon steam users by increasing steam pressures and increased difficulties of lubrication therewith.

When the exhaust steam or condensed water is thrown away and a fresh supply of feed water is introduced there is a constant influx into the boiler of impurities in solution or in suspension in this water. The former, i. e., those in solution, are to a large extent insoluble in hot water so that the heating of the water precipitates them. By simply heating the water before it reaches the boiler they may be precipitated in auxiliary apparatus more easily cleaned than is the boiler itself. Impurities carried along in suspension as a rule collect at the water level within the boiler and may be skimmed off therefrom by cleaners of the surface blow-off type, a number of which are described in an article on other pages of this issue. This article is the beginning of a number of discussions of the whole range of purifying apparatus for use with steam boilers, which articles will be continued regularly in these columns until their completion.

### The Hull as a Return for Marine Plants.

In the leading article of this paper there will be found a description of a high-grade English ship-lighting plant in which the hull of the vessel is used as the return conductor of the distributing system. In this country marine equipments were at one time arranged in this way but the practice has gradually gone out of favor, a complete two-wire insulated system now being the universal rule in American-built ships.

Among the reasons which have been given for this change in American practice are the added risk of grounds, the deflection of the compasses and the danger —probably more fancied than real—that electrolysis or heavy burn-outs would seriously affect the ship's structure or plating. That the English builders use the system in such a ship as that described on another page, which is the largest and most expensive craft afloat, proves that none of these objections can be very serious, and that there must be compensating advantages.

The first and chief of the advantages is of course the reduced cost of the wiring. As the return circuit has an enormous cross section there is practically no drop of voltage in it. The whole drop being concentrated in one side of the system the conductors can be made one-half the cross section necessary to give the same drop in a two-wire system; thus the amount of copper is reduced 75 per cent, a reduction greater than that obtained by the use of a three-wire system.

In addition to the reduced amount of material the work of construction is greatly simplified. No twin wires are necessary, each feeder, main and branch being a single conductor with single-pole switches and fuses. The switchboard is also greatly simplified, there being no need of a negative bus and switches and double-pole fuses. Indeed, there is no need of even running the negative leads from the machines to the board, although in the plant referred to above the single-pole fuse for each machine has been put on the negative lead between the machine and ground in order to protect against grounds within the machine, and for the sake of convenience the fuse has been placed upon the switchboard.

This hull arrangement gives twice the strain on the insulation between the positive and ground that exists in two-wire

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insulated systems, but this strain is slight in such low tension circuits, insufficient to do physical harm or break down insulation with any dielectric strength whatever. With two-wire systems in case the insulation of one polarity gives away at any point the ground immediately becomes a network carrying the current from the fault to any weak point that may develop on the other polarity. In one-wire systems all the insulation is placed to one side of ground and a weakness at any point through half the insulation is not distributed to any weak points through the other half.

An old rule has been revised by some modern wit into the form "put all your eggs in one basket and then watch that basket." To paraphrase this revision the English prefer in marine plants to put all their insulation on one pole and then watch that pole.

**A New Departure in Alternating Current Regulation.**

It is well known that the drop in alternating-current generators with increase of load is as a rule much greater than that in direct-current machines of the same size and with the same load increase. This is due to the self-induction of the windings caused by magnetic leakage from the armature coils that does not pass through the field coils. In addition, when the load of an alternator becomes inductive, the armature exerts a direct demagnetizing effect upon the field for which there is no analogue in direct-current machinery.

Single-phase alternators in small sizes are customarily composite-wound, the current passing out to the line or a derived current proportional thereto being rectified and used to help excite the fields. While this current is effective for non-inductive loads, when the load becomes inductive and the demagnetizing action of the armature is increased thereby, the composite winding fails to make up for it and the voltage of the machine falls just at the time when it should rise in order to overcome the increased inductive drop of lines and transformers.

Composite winding does not adapt itself to polyphase machinery and is rarely used on large generators. The result is that such machines in order to obtain close regulation are necessarily rated at an output frequently much less than they could carry if limited only by danger of overheating. In other words, the machines are more heavy and more expensive per kilowatt output than would be the case if it were not for difficulties of regulation.

On another page there will be found a description of a new line of alternators which are in a sense compounded, the compounding being effected through the exciter on a new principle of alternating-current regulation. In a paper recently read by Mr. H. G. Reist before the Ohio Electric Light Association the results obtained by this method of excitation were illustrated by a striking example which may be quoted as follows: "I have seen a 50-h. p. induction motor started from a 75-kw. generator with a drop in potential on the line just sufficient to fluctuate the voltmeter and lasting perhaps one-half second, but the effect on the lights could be detected only on close observation. At the same time it was noted by the tachometer on the machine that there was a momentary drop in speed so that beyond a doubt the slight fluctuation was due to this cause." Such results are far from attainable in ordinary separately excited or composite-wound machines and indicate a new departure in alternating-current regulation which will go far toward overcoming the previous poor qualities of alternating-current machinery in this respect as compared with direct-current machinery and will allow the more general use of a.c. motors without serious disturbing effects.

**An Expedient for Troubles in Parallel Running.**

With a battery of compound wound direct-current machines which usually run perfectly in parallel with each other it often occurs that one machine suddenly develops a tendency to alternately shirk the load and attempt to carry the whole of it. This tendency—as is well known—is due to poor contacts somewhere in the circuit, such poor contacts being liable to develop at any time owing to a burned switch blade, a loose nut or other causes. It might be incidentally remarked right here that the poor contact need not be in the equalizer since the satisfactory running of compound wound machines together depends on the perfection of paralleling the series fields and a poor contact in the positive bus bar (if the series fields are on the positive side of the system) may disturb this paralleling.

When this trouble does occur it usually requires some time to locate it, and any means of operating the machine affected during this time may prove valuable in stations the generating equipment of which is heavily loaded. Such a means may be borrowed from experience in alternating current stations. As is well known, the division of the load between alternating current generators depends solely upon the governors of the engines driving them. If two engine-driven alternators are running in parallel and the governor of one is thrown out of service with the cut-off fixed so as to give steam enough for, let us say, 100 kilowatts, this unit will continue generating 100 kilowatts and the other one will supply the balance necessary to carry the load, its governor taking up the whole of the fluctuations. This method of working is quite commonly used where the loads are reasonably steady and particularly in water power plants where individual governors on each machine are likely to give trouble.

In direct current plants the same expedient may be adopted for machines giving trouble in the manner pointed out above. If one machine unexpectedly develops a tendency to see-saw its load the trouble may be temporarily remedied until a permanent cure can be found by blocking its governor and running its engine at fixed cut-off. It will then deliver to the bus bars a constant number of kilowatts at a voltage determined by the excitation of the other machines. The reason for this action and for the fact that any change either of its shunt or series field does not disturb its load may be explained as follows. If, for example, the current through its series field is suddenly increased the voltage will tend to rise above that of the other machines and the output will tend to increase. The lack of steam to give this increased output will check this tendency and the speed will fall, maintaining the voltage and output at the previous values, the engine thus automatically adjusting its speed so as to deliver practically the same energy to the bus bars whatever the field excitation may be.

This expedient is a valuable one in cases where the equalizer fails and the series field would otherwise tend perhaps to weaken the magnetism and make the machine run as a motor and race, carrying the engine with it. The blocking of the governor in this case absolutely prevents any reversal of the current through the series field. While of course it is unsafe to run a machine in this way without closely watching it when the load is likely to fall below the output for which it is set, still there are many cases where the smallest probable load is greater than that generated by one machine. In such cases this method of running is safe.

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# THE APPARATUS FOR THE COMMERCIAL GENERATION OF OXYGEN AND HYDROGEN BY THE ELECTRIC CURRENT.

BY W. S. FRANKLIN.

During the year 1895 a novel form of electrolytic generator for oxygen and hydrogen was constructed and tested at the physical laboratory of Iowa State College.* During 1896 this generator was greatly improved, and a large generator of twenty cells was constructed and tested. The results of this test showed that practically pure oxygen could be produced at the cost of 1 cent per cubic foot (counting hydrogen as of no value), rating electrical power at 2 cents per kilowatt hour. This early type of generator was identically the same in design as the generator described below, except that the electrode frames and all pipes were made of lead and the electrolyte was dilute sulphuric acid.

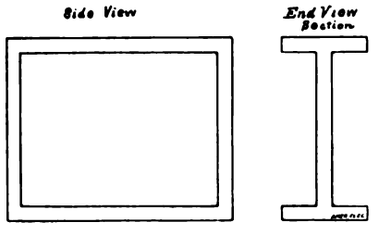



FIG. 1.

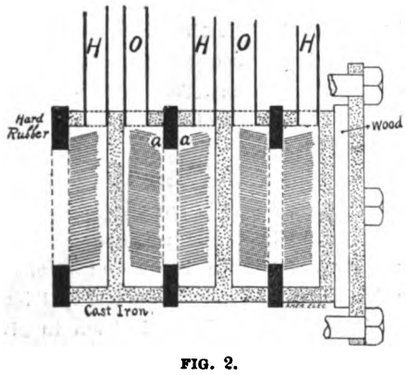



FIG. 2.

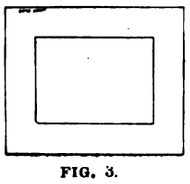


FIG. 3.

During 1898 an electrolytic generator was constructed and tested† at the physical laboratory of Lehigh University. This generator was made by bolting together a number of massive cast iron frames of the form shown in Fig. 1. These frames were separated by hard rubber plates, as shown in Fig. 2, and the central portion of each hard rubber plate was cut away, as shown in Fig. 3. The chambers between the frames were filled with caustic soda solution of the maximum electrical conductivity and the cast iron frames served as electrodes.

To prevent the mixing of the gases by currents of the liquid, slotted hard rubber posts were placed on either side of the hard rubber plate and in these slots a large number of strips of sheet iron were supported, as shown in Fig. 2. These strips of sheet iron were insulated from the electrode frames, and, inasmuch as the electromotive force used per cell is considerably less than twice the minimum e. m. f. required to generate oxygen and hydrogen, there is no tendency for the gases to be generated upon these sheet iron strips.

The complete generator (3 cells) is shown in Figs. 4, 5 and 6. Two ½-inch gas pipes pass upward from each cast iron frame. These ½-inch pipes terminate in ¼-inch pipes, each of which contains an insulating junction and bends over and connects to one or the other of two large and slightly inclined collecting pipes, C′ and C″. These pipes, C′ and C″, connect at their lower ends to two traps, through which the liquid that is thrown over by the gases may escape; at their upper ends the pipes C′ and C″ connect to the pipes which lead the gases to the storage tanks. Connected to the bottom of each cast iron frame is a ¼-inch pipe which bends upward and terminates in a cup, through which fresh electrolyte may be introduced into the electrolytic chamber. At the bottom of each cast iron frame are two ½-inch drain pipes for use in washing out the apparatus.

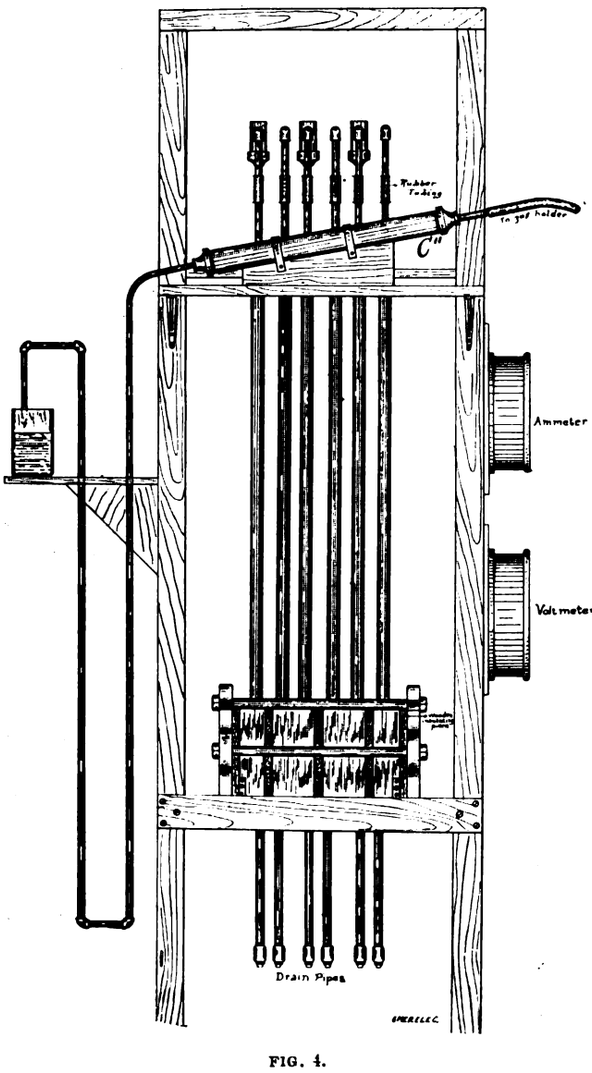



FIG. 4.

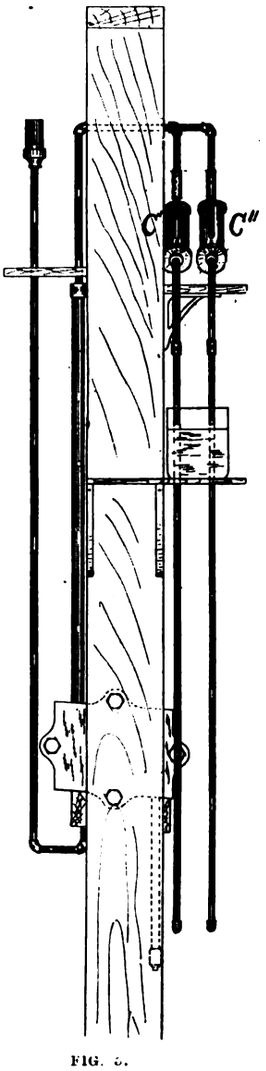



FIG. 5.

### EFFICIENCY OF GENERATION.

During the passage of one ampere for one second through an electrolytic cell .00001039 gram of hydrogen and a corresponding amount of oxygen are liberated. Now, the combustion of 1 gram of hydrogen gives 34,200 calories of heat, or 143,600 joules, so that the recombination of .00001039 gram of hydrogen with oxygen would give 1.45 joules, which is the amount of work that would be done by 1.45 volts of e. m. f. in pushing the one ampere of current through the electrolytic cell for one second. Therefore, if the e. m. f. used to push the current through the electrolytic cell were exactly 1.45 volts, then all of the work done in pushing the current through the cell would be represented by the heat value of the hydrogen and oxygen obtained and the efficiency of the apparatus would be 100%. As a matter of fact, however, the e. m. f. needed to push the current through the cell is in excess of 1.45 volts

* See Physical Review IV., 61.
† Thesis of H. J. Horn and Paul Bucher, 1898.

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and the efficiency is therefore less than 100%. In fact, if E is the e. m. f. actually used to push current through the cell, then

$$\mu = \frac{1.45}{E}$$

in which $\mu$ is the efficiency of generation.

RESULTS OF TESTS.

The tests carried out by Messrs. Horn and Bucher included tests of the purity of the gases and determinations of the efficiency of generation for various rates of generation. They found the gases to be about 98% pure, the impurity in the oxygen being hydrogen and vice versa. This degree of purity leaves nothing to be desired when the gases are to be used for heating purposes. When the gases are to be used for analytical purposes in the chemical laboratory, a higher degree of purity is desirable and can be attained by increasing the distance between anode and cathode and by exercising care in the arrangement of the sheet iron strips shown in Fig. 2. For the best effect these strips should be fitted into slots in the rubber separating plate at a, Fig. 2, to prevent a downward current of liquid at a. With some care in this particular the mixing of the gases can be entirely prevented. For example, the cells which gave 98% purity, as stated above, gave 99.9 purity after a slight modification of the sheet iron strips, the hole in the hard rubber plates being made slightly smaller also.

With a current of 10 amperes the e. m. f. required per cell was 3.6 volts and the efficiency was therefore 41%. This current of 10 amperes was about as much as the cells could stand continuously without excessive heating.

The curve, Fig. 7, shows the e. m. f. required per cell for various currents and the curve, Fig. 8, shows the efficiencies of generation for various currents.

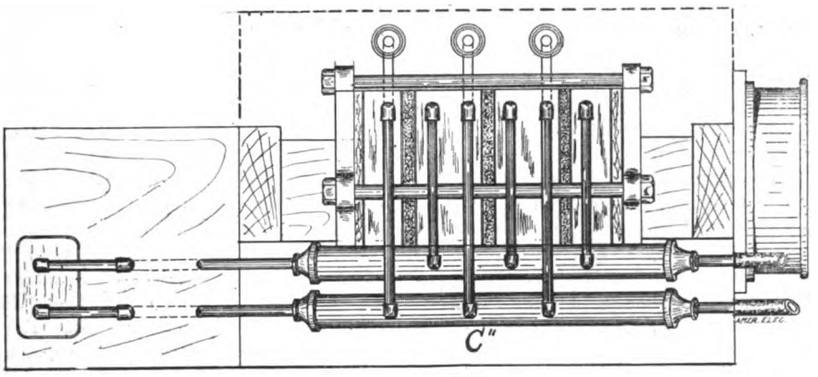


FIG. 6.—TOP VIEW.

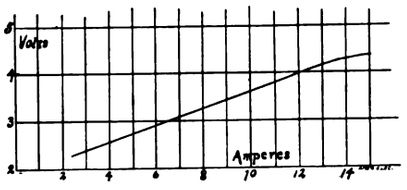



FIG 7.

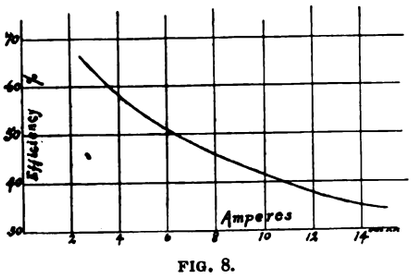



FIG. 8.

CONCLUSIONS.

The electrolytic generator here described is entirely satisfactory in every particular. There is no corrosion of the electrodes and the hard rubber withstands the action of the caustic soda perfectly. The efficiency under practical conditions is as high as 40%, and oxygen and hydrogen may be produced more cheaply by means of this generator than by any other method.

## AMERICAN TELEPHONE PRACTICE.

### COMMERCIAL WHEATSTONE BRIDGES.*

BY KEMPSTER B. MILLER.

A particular form of bridge which has come into extensive use in this country and which possesses several unique features is shown complete in Fig. 1.

The various adjustments of the arms are accomplished by placing plugs in the various holes between the brass blocks arranged in rows, as shown in the diagram, Fig. 2. Between each successive pair of blocks are arranged resistance coils having the resistances in ohms designated on the plan. Placing a plug in a hole between two blocks short circuits the resistance connected between those two blocks. The rheostat arm of this bridge is represented by the top and bottom rows of blocks and if all plugs are removed the resistance in this arm will amount to 11,110 ohms. The ratio arms A and B are represented by the left and right-hand halves respectively of the center row. A galvanometer and suitable battery, together with battery and galvanometer keys, are all mounted in a carrying case as shown.

The connections of this instrument are indicated in Fig. 2, and are as follows: The top row of blocks is connected to the bottom row by a heavy copper bar joining the right-hand blocks. This connection is made very heavy, so as to interpose no extra resistance in the rheostat. On the rheostat formed by the upper and lower rows of blocks any resistance from 1 to 11,110 ohms may be obtained, the resistance being added by leaving out plugs. The lower left-hand block of the rheostat is connected to the lower binding post, D, forming one terminal of the unknown resistance.

The upper post, C, forming the other terminal of the unknown resistance, is connected to block, X, which block is also joined to the galvanometer key. The block, R, is connected to the upper left-hand block of the rheostat. The end blocks of the middle row are connected together and to the + terminal of the battery. The — terminal of the battery is connected through the battery key to the lower left




FIG. 1.—A COMPLETE WHEATSTONE BRIDGE.

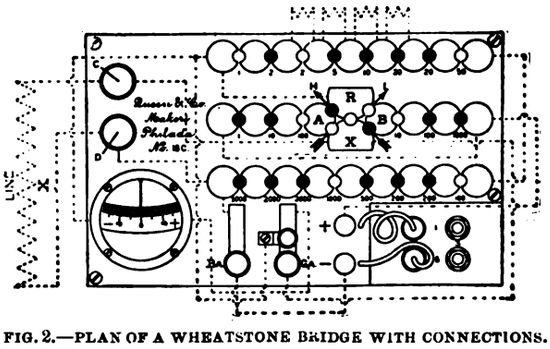



FIG. 2.—PLAN OF A WHEATSTONE BRIDGE WITH CONNECTIONS.

*From a book to be published by the American Electrician Company.

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hand end of the rheostat. One galvanometer terminal is connected directly to the block, R, the left-hand block of the rheostat, and to the back contact of the galvanometer key. The other galvano-

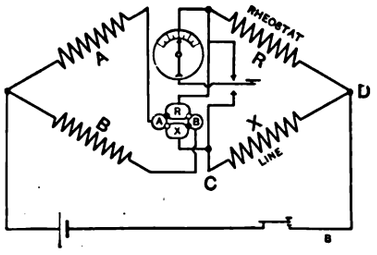



FIG. 3.—DIAGRAM OF BRIDGE SHOWING REVERSING COMMUTATOR.

meter terminal is connected through the key to the block, X.

By carefully following out these connections it will be apparent that the parts as connected form three arms of a Wheatstone bridge, the fourth, of course, being the unknown resistance joined to the line posts. This is shown diagrammatically in Fig. 3, where the corresponding parts are similarly lettered.

It will be noticed that this latter figure is practically the usual diagram, with the addition of the center blocks, A, B, X, R, forming a sort of commutator. The object of this arrangement is to make it possible to reverse the connections of arms, A and B, with R and X.

The bridge arms, A and B, have not the same range of resistances in this bridge, A having only 1, 10 and 100 ohm coils, while the resistances of B are 10, 100 and 1000 ohms. Therefore, if a ratio of 1000 to 1 for measuring large resistances is desired, the plugs are inserted in the commutator as shown; while an opposite arrangement of the plugs in the other holes will give a ratio of 1 to 1000 for very small resistances. In this bridge the galvanometer key is so arranged as to short-circuit the galvanometer while the key is up.

The galvanometers usually furnished with the complete bridges consist of a needle so mounted as to swing freely in a horizontal plane. This needle is given a tendency to point in one direction sometimes by the action of the earth's magnetic field and sometimes by the field of a powerful permanent magnet. By causing the current through the bridge wire to flow through a coil, either stationary and surounding the needle, or movable and carried on to the needle, the needle is caused to swerve from its normal position and to place itself at right angles to the lines of force due to the permanent field. The deflection of the needle is great or small, according to the strength of the current, and to the right or left according to the direction of the current.

In many of the tests to be described later a galvanometer of greater sensitiveness is required, and some form of reflecting instrument is used. In these the needle carries a small circular mirror, which reflects a spot of light from a lamp on some other source against a scale. In this arrangement every movement of the needle causes the spot of light to move along the scale, and a little consideration will show that the angle through which the reflected ray of light moves is double that through which the needle travels. Thus this reflected ray of light serves as a needle of any desired length, and has the advantages of magnifying the angular movement of the needle to twice its real amount, and of possessing no mass, and therefore no inertia.

The two galvanometers used to the greatest extent for quantitative measurements in practical work are the Thompson and the D'Arsonval.

The Thompson galvanometer is made in a great variety of forms. The needle consists of several very light bar magnets arranged side by side and with opposing poles together, so that the directive influence of the earth's field shall be very slight. The needle is directly attached to a small silvered glass mirror, and is suspended within the coil or coils by means

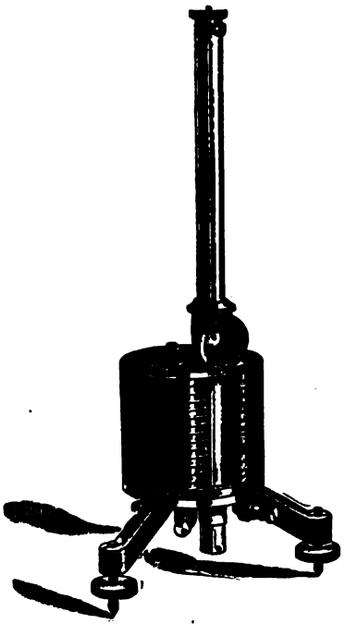


FIG. 4.—A D'ARSONVAL GALVANOMETER.

of a silk or quartz fiber. The current to be measured is passed through the coils, and the magnetic field set up thereby causes the needle to swerve from its normal position. The Thompson galvanometer is used in the most delicate tests, and is essentially a laboratory instrument. It has the disadvantage of being affected to such an extent by external magnetic fields as to render its use impossible in many cases. A passing street car or variations in the current flowing in a neighboring circuit will cause the needle to swing violently, thus making accurate work out of the question. These disadvantages may be overcome to some extent by inclosing the galvanometer in a heavy iron case—such as an old safe—but they tend to make it a very undesirable instrument for portable work. Where the instrument can be permanently set up and properly guarded, it is unequaled for delicacy and accuracy.

For nearly all practical engineering work, the D'Arsonval galvanometer is sensitive enough, and has the alvantage of being much more convenient for general work. In this the needle is a coil instead of a permanent magnet, and is suspended within the field of a powerful permanent magnet instead of a coil. The needle carries a mirror, as in the Thompson instrument. The current to be measured is passed through the coil, and as this coil lies in the field of the permanent magnet, a rotation of the coil ensues, the action being identical with that which causes the armature of an electric motor to revolve.

In Fig. 4 is shown a much used form of D'Arsonval galvanometer made by Queen & Co., Philadelphia. The field is built up of a number of horizontal permanent magnets, between the poles of which is suspended the needle.

The great advantage of the D'Arsonval galvanometer is that it is unaffected by variations in the external magnetic field. It may even be used close to dynamo machinery, without being sensibly affected.

In order to read the deflection produced by a current, in any form of reflecting galvanometers, two methods may be employed. One is to cause the needle to reflect a spot of light from a stationary source, upon a horizontal scale, and by watching the movement of the spot the number of scale divisions deflection may be accurately determined. Another and better way is to focus a telescope on the mirror, in such manner that the horizontal scale will be visible in the telescope. The mirror in its movements will reflect different portions of the scale into the telescope, and the deflection may thus be observed with great precision. When this method is used the numbers on the scale should be reversed, in order to appear normal in the telescope. Fig. 5 shows a telescope and scale as arranged for this purpose.

Complete testing sets, containing reflecting galvanometers, bridges, batteries, keys and other accessories, are frequently mounted in one case, and so arranged as to fold within small compass when not in

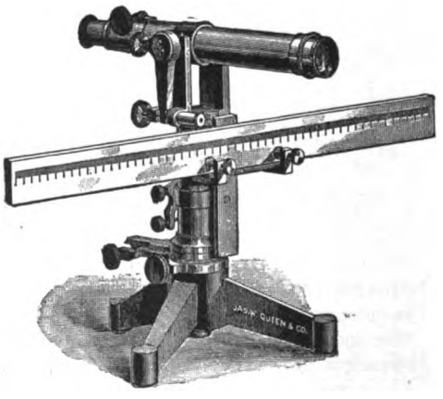


FIG. 5.—A TELESCOPE AND SCALE FOR GALVANOMETER USE.

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use. This arrangement is very convenient, but has one disadvantage—the manipulation of the keys and plugs jars the box to such an extent as to make the readings on the galvanometer unreliable. The separately mounted galvanometer is, therefore, in general, to be preferred. Of course this applies only to reflecting galvanometers.

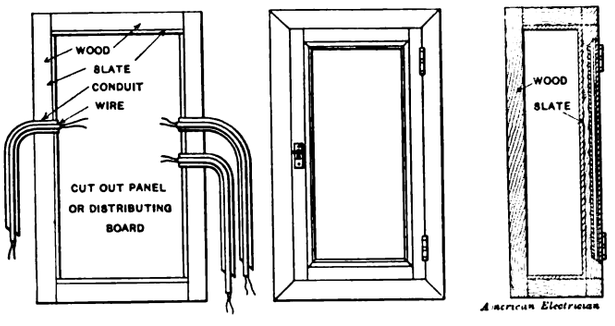
## INTERIOR WIRING.

BY CHARLES E. KNOX.

### CUT-OUT CABINETS.

In hardly any other branch of interior wiring have so great improvements been made as in the method of protecting the branch and main circuit wires by fuses. This improvement has been not so much in the direction of the fuse itself, as the method of inserting the fuse in the circuit and in making connections at the points where the conductors were interrupted or reduced in size, to place the fuse in circuit.

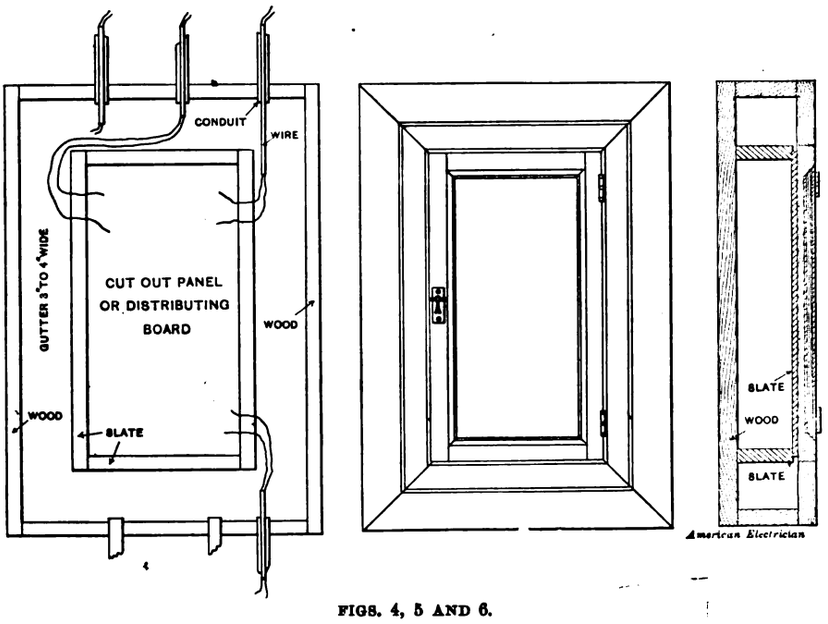
In former days the Edison porcelain plug fuse was used almost exclusively for the purpose of protecting circuits from overload. This fuse plug was not as bad as the outfit of which it formed a part. The fuse was self-contained, easily replaced (when one blew out) and had the advantages that all enclosed fuses have. The fuse blocks of which these fuses formed part were very inadequate for the purpose. The first ones were made with wooden bases; these were followed by porcelain blocks of the same style and design. In both cases the connections with the wires were made by screw contacts. With small sizes of wires this was not objectionable, but with the larger sizes of wires the contact was very poor. Where stranded wires were used, two or three strands would be in contact and the rest would be spread out, carrying little or no current. No attempt was made to enclose the fuse blocks or the wires. A piece of mica was placed over each block to cover the wires and contacts, but this generally disappeared after the block had been in use for a short time.




FIGS. 1, 2 AND 3.

The first great improvement was made by the introduction of the panel type of cut-out distributing boards. This consisted of a slab or tablet on which were mounted bus bars and connecting bars for making the connections between the main wires and the branch circuit wires. In these boards fuse wire was used instead of the fuse plugs. All the connections in these early panel boards were made at the back of the board—a method which was as dangerous as it was inconvenient. This type was soon followed by tablet or panel boards having front connections for all the wires. Then followed the present type of cut-out in which the fuse is "removable," i. e., the fuse is contained in a movable block having contacts at each end between which the fuse is connected. In case the fuse is blown the whole block may be removed and replaced by another one and the fuse in the first one replaced at leisure.

All the panel type of cut-outs are now installed in a wooden box or cabinet. We will, in the present number, discuss this cabinet, the method of bringing the conduit and wires to the cabinets and the means used in making the connections. In the next number we will discuss the panels or distributing boards themselves.




FIGS. 4, 5 AND 6.

The first cabinets consisted of a simple box of general form and design, shown in Figs. 1, 2 and 3. The panel was screwed to the back of the box. The sides and door of the box were usually lined with asbestos paper. With this type of cut-out cabinet (called the single box) it is necessary to bring each conduit and wire opposite the point at which it connects with the panel. This is very objectionable for the following reason: As the conduit tubes all come from the floor or from the ceiling, it is necessary to make bends or put elbows in the conduits in order to bring them to the proper points at the sides of the box. This makes an expensive piece of work and also makes it necessary to cut the partition or wall in which the cabinet is placed.

With the double type of cut-out cabinet shown in Figs. 4, 5 and 6 it is not necessary to bring the tubes at any particular point, as provision is made whereby the wires may be brought to the proper point. The means for doing this consists of a compartment (called a gutter) between the outer wooden box and the inner slate box. In this space the wires may be run, from the point where they leave the conduit to the point where they enter the slate sides of the inner box. The advantages of this method are obvious. As seen from the drawings, the door only opens on the panel, the "gutter" being covered by the trim of the box, which is fastened in place by wood screws. Whenever it is necessary to get at the wires between the conduits and the slab, it is only necessary to remove the trim of the cover. This method has now been in use for several years and has given better satisfaction than anything else yet devised for the purpose.

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## BOILER CLEANERS OF THE BLOW-OFF TYPE.

It has always been a difficult problem the keeping of oil, grease and earthy matter from accumulating in steam boilers, and probably the surface and bottom blow-offs are about as efficient as any other apparatus ever devised for that purpose. The surface blow-off has been improved and added to by many engineers and inventors, for the purpose of adding

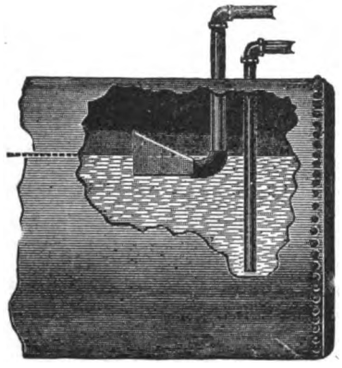


FIG. 1.—TRIUMPH BOILER CLEANER.

to its efficiency, but it still remains a surface blow-off, although it is in an improved form.

The succeeding illustrations present some of the best known forms of boiler cleaners; or "improved surface blow-offs," as they may well be designated. While these cleaners are designed to clarify all the water that is pumped into the boiler, other forms are designed only to abstract oil and grease from the water of condensation that is to be returned to the boiler. Closely allied to this type of grease extraction is the steam separation which is used for separating from the passing steam any water of condensation. In some cases there is little difference between the steam separation and the grease extraction, and in a number of in-

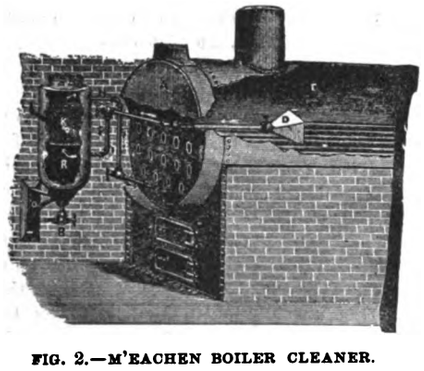


FIG. 2.—M'EACHEN BOILER CLEANER.

stances the same appliance is used for both operations, the apparatus being termed "steam separator, grease extractor and exhaust head." Nearly all water catchers may also be used for extracting grease, but as the duty of one is manifestly between the boiler and engine, and the other in the exhaust pipe, there should be some difference in construction to ensure the best results.

The boiler cleaners are several in number, and all work upon nearly the same principle—that is of a skimming dish placed at the water level. Fig. 1 shows the arrangement very clearly; this cut represents the Triumph Boiler Cleaner, made by S. W. Baid, St. Louis, Mo.

In this cleaner, as in nearly all others, the water is drawn from the water line, passed through a settling tank and then returned to the boiler again. The mechanical power necessary to circulate the water as above is taken from the energy contained in the boiler itself. A closed tank, somewhat resembling an ordinary heater, or a hot-water tank as attached to the kitchen range, is connected as shown by Fig. 2, which also represents a form of the McEachen boiler cleaner, as attached for use in water containing mud, vegetable matter and oil. A filter is shown in the settling tank, and the foreign material is separated from the water therein. But the action of the apparatus thus arranged is very slow, and the circulation is not as good as in the improved forms of this boiler cleaner, which are illustrated by Figs. 3 and 4. The arrangement of the filter, shown in Fig. 2, makes the operation of the device necessarily very slow. This has been modified in another form of cleaner, by the same maker, as shown by

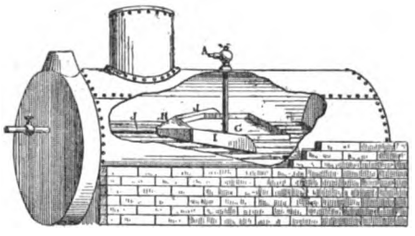


FIG. 4.—M'EACHEN BLOW-OFF CLEANER.

Fig. 3. Here the principle is clearly shown which causes a circulation of water through the cleaner. Hot water flows through the skimming dish and connecting pipes to the settling chamber. There the body of water becomes cooled through radiation of its heat, therefore it becomes heavier and forces itself back through the connecting pipes into the boiler again and below the water line plainly by the action of gravity.

This simple form of cleaner has the usual "skimming dish" at the water line, and it also has a number of pans arranged in a conical pile in the steam space. The feed water enters the upper pan and trickles down over the rest of the pans, becoming very hot in its passage through the steam space. This form of cleaner is especially desirable, for only sulphate of lime, iron, salt and other minerals which form into scale when heat is applied are found in the water.

Still another form of this cleaner, and a very simple form too, is shown by Fig. 4. In this arrangement the settling tank is dispensed with, the pans are removed and the feed pipe is brought down directly into the shallow pan, which is connected with the "skimming dish." The device is used merely as a surface blow-off, but only matter contained in the pan can be blown off unless the water is at too high a level in the boiler. This arrangement is for mud, magnesia, vegetable matter and oil. Where only these substances are contained in the water, the device shown by Fig. 4 may be used to advantage.

Trouble has been experienced, in using surface skimmers because of the varia-

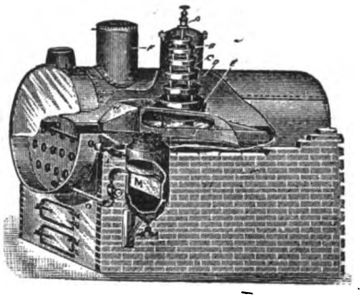


FIG. 3.—M'EACHEN CLEANER WITH PANS.

tion in the water level. The cleaner, illustrated by Fig. 5, is so constructed that it will not be drowned one minute and located high and dry the next. This is done by making a "three-story" skimmer, as shown in the engraving in question, so that as the water level varies, the upper, lower or intermediate skimmer may be in position for active service. This cleaner is sold by Foster, Hester & Co., Chicago.

One of the earliest forms of boiler cleaners of this type is that shown in Fig. 6, and made by Mr. Jas. F. Hotchkiss, New York City. In this cleaner, as in the others described above, the skimming device or funnel is connected with a reservoir outside of the boiler, in which reservoir or settling basin the material collected from the surface of the water in the boiler is deposited, but the cleaner differs from those above described in that

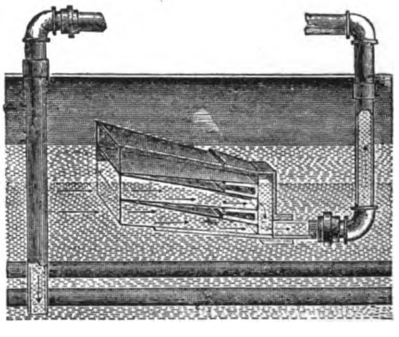


FIG. 5.—BROWN MECHANICAL CLEANER.

its arrangement is more simple and compact. The reservoir is placed immediately on top of the boiler, making the piping short and the radiation and waste of heat small. With the rest of the boiler this reservoir or settling chamber and the piping to it may be covered with heat insulating material, the circulation continuing

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and apparently not depending upon the cooling of the reservoir.

Of the parts shown in the illustration, B is the settling chamber, which is spherical in shape and rests directly upon the boiler shell, A A. The circulation is maintained in the direction of the arrows from the funnel or skimming device, C, through the uptake, D, and down through pipe, E. The chamber, B, is crossed by a diaphragm, G, which compels the water

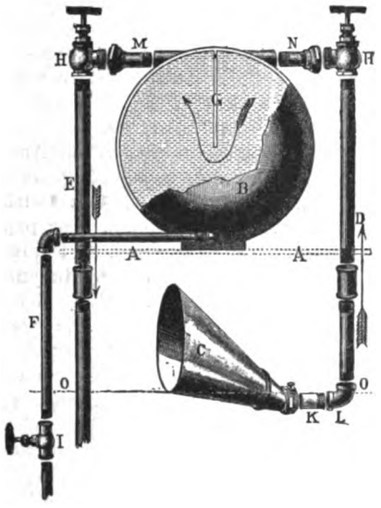



FIG. 6.—THE HOTCHKISS BOILER CLEANER.

to pass downward around it. The low velocity due to the increased cross section of the lower half of the chamber compared with that of the pipes permits the water to deposit any solid particles in this chamber. In the upper part of the diaphragm is a small air hole provided to start the circulation, the water of the boiler absorbing the air of the reservoir and filling the latter automatically when the boiler is newly put in service. F is the usual blow-off pipe for removing the deposits.

## THE EFFECT OF HEAT ON BABBITT METAL.

Almost any solid metal for lining bearings is called by the name "Babbitt metal," while in fact few of the soft linings used have any claim whatever to that title. The genuine alloy which was compounded by John Babbitt and which bears his name, is composed of eight (8) parts regulars of antimony (regular means the pure, refined metal), four (4) parts copper and ninety-six (96) parts of tin.

Ordinary soft lining, so-called "Babbitt metal," frequently is made up of four (4) parts lead and one (1) part antimony. Old type metal is also used for lining and consists of two (2) parts lead, one (1) part tin and one (1) part antimony. Britannia metal (pewter) is also much used for lining, and this consists of nine (9) parts tin and one (1) part antimony.

It will be noted that all the alloys above described are partly of antimony, and also contain either lead or tin, both easily oxidized metals. But antimony is even more easily oxidized and will burn in the open air if too highly heated, much like zinc. Thus, when either of the alloys described above are frequently heated, the different metals become oxidized, but burn out in different ratios to each other, thereby changing the nature of the alloy to a certain extent each time it is heated.

Genuine Babbitt will probably change its form more by re-heating than the alloys of antimony and lead, but the latter are reduced the most in quantity. The reason therefor is that the copper and tin oxidize more slowly than the antimony, which quickly burns out, leaving the Babbitt much softer than it was before getting rid of some of its antimony. Lead oxidizes much more freely than either copper or tin, therefore the alloy retains more nearly its original composition when a quantity is burned off or oxidized, still the antimony burns out faster than the lead, reducing the hardness of the alloy, but not to the extent it does when mixed with tin and copper.

Under proper conditions any kind of Babbitt metal may be melted and even kept indefinitely in a molten condition without oxidization, or, in everyday language, wthout the forming of dross on the surface of the molten metal. To secure this result protect the metal from the atmosphere. A layer of dirt on top of the molten metal will do it; even a layer of oxide or dross is a good preventive; therefore do not skim off the layer of oxide as fast as it forms, but let it stay on top of the hot metal.

A very good way is to cover the metal in the ladle or melting pot with pulverized charcoal. Carbon largely retards the process of oxidization, and if some salt and soda (common washing or cooking soda) be added to the coarsely powdered charcoal, the oxide will be reduced; that is, the dross will be smelted back into the metal again.

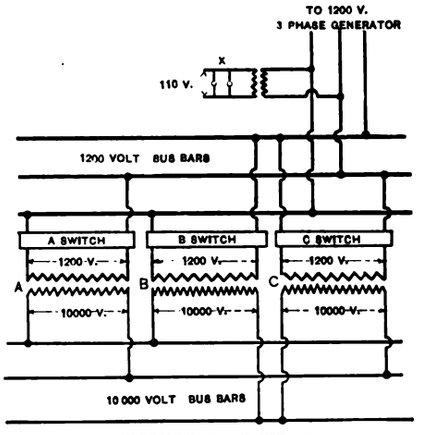
Another great preventive of oxidization of Babbitt metal lies in not heating the metal too hot. For all except very small bearings, where the layer of metal must run very thin, there is no need of heating the metal very hot. Just hot enough to barely char a dry pine stick is a good rule to follow when heating Babbitt metal. But whittle the stick every time the metal is tested, so a fresh wooden surface is exposed thereto.

# Letters on Practical Subjects

## A Polyphase Puzzle.

*To the Editor of American Electrician.*

Sir—The accompanying diagram of circuits illustrates an electric puzzle with which I had to contend some time ago. An 80-h. p. synchronous motor was temporarily used as a generator and connected to the three upper wires running to the 1200-volt bus bars shown in the accompanying diagram. Three 75-kw. step-up transformers connected these bus bars with three 10,000-volt bus bars connected to a high-tension transmission line, but at the time the puzzling conditions arose the switches to this transmission line were open and there was no other connection to the 1200-volt or the 10,000-volt bus bars. To one phase of the 1200-volt system a 20-light transformer, shown at X, was connected and was used for lighting the transformer sub-station. Each step-up




A POLYPHASE PUZZLE.

transformer was supplied on its low tension side through a double pole switch, these switches being shown at A, B and C. With these switches all open we obtained no light at X and one closed gave the same result. With another switch closed the lamps came up to full voltage while with the three switches, A, B and C, all closed, or any other combination than those mentioned above, the lamps came up to approximately half their proper candle power. We discovered afterward that one of the fuses of the temporary generator was out. The problem arises which fuse was out and which switches gave the different results named.

F. B.

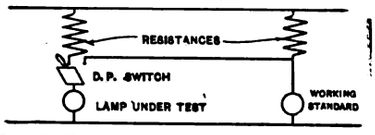
## The "Same Circuit" Method of Incandescent Lamp Photometry.

*To the Editor of American Electrician:*

Sir—In an article upon the above subject, appearing in the last issue of your journal, I notice you mention the care that must be taken when turning off the lamp under test to prevent the diminished drop in the rheostat feeding the lamps from overburning the working standard. In practice a much more satisfactory arrangement than that shown in your diagrams has been developed, which consists in the use of two separate resistances, one for each lamp, and connected in series with that lamp as shown in the accompanying figure. If, then, one lamp is turned off, the voltage on the other one is not changed. The drawback to this method is that incandescent lamps, although supposed to be similar, are not exactly identical in resistance.

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Therefore this method of working would introduce an error wherever the resistances of the lamps departed from the average, due to the fact that the drop in one resistance would vary while that in series with the working standard would remain constant. This can be compensated for by putting an equalizer wire between the lamp terminals and arranging




THE CONNECTION OF TWO RESISTANCES AND AN EQUALIZER FOR THE "SAME CIRCUIT" METHOD OF PHOTOMETRY.

to have the circuit through this wire broken at the time the lamp being measured is removed from the socket.

In central station work this can be done by means of a double-pole switch as indicated in the diagram. In case rapidity in the measurement of a large number of lamps is desired, the insertion of the lamp to be tested can be made to close the equalizer wire circuit automatically and open it again when the lamp is removed.

S. E. Doane.

Marlborough, Mass.

## Floor Outlets in Large Offices.

*To the Editor of American Electrician:*

Sir—I notice an editorial in your issue of October in relation to floor outlets in large offices. Some time ago there was designed by officials of this company a floor trough which seems to answer so admirably the purposes of accommodating telephone, buzzer and other signaling conductors that a description of it may be of interest at this time.

Telephone, telegraph, ticker, bell wires, etc., can not be laid out in advance, as the requirements of future occupants of offices in respect to such service can not be foreseen, and each occupant is liable to want something different from that which his predecessor had. To reach all parts of a room with invisible wiring, and at the same time avoid tearing up floors whenever an installation or a change is desired, small wooden troughs have been used in the new building of the Chicago Telephone Company, now in the course of erection. These are placed immediately under the floors every four or five feet and running entirely across the room. At the ends of these troughs means are provided for bringing up the wires, which can also be reached at any point out in the room by boring a hole into the floor.

Connecting with the ends of these troughs there is provided around the base of the walls molding in which the wires can be carried, and which can readily be removed, thus uncovering the entrances to the wire ducts. To take the vertical wire-runs, a conduit is placed in a shaft of the building and openings are arranged on each floor. The course of a circuit, then, is through this conduit to the desired floor, thence through the floor molding to the proper room, and on through the molding and floor conduit to the desired location in the room.

This provides an accessible conduit which will enable wiremen to reach a desk at any point in the room in a ready manner, and when it is placed before the floors are laid it is, perhaps, the cheapest form of conduit which can be used.

In the new Marshall Field building, where tile floors are to be laid, tin pipes are to be imbedded in the cement filling every four feet across the room. An outlet will be provided at each end of these pipes along the walls, and if necessary they can be reached at any point in the room by drilling through a tile under any desk which the occupant may desire to reach with electric service. Architects and owners will do well to remember that the provision of such inexpensive conduit will save largely in subsequent wear and tear of the floors and walls of the building.

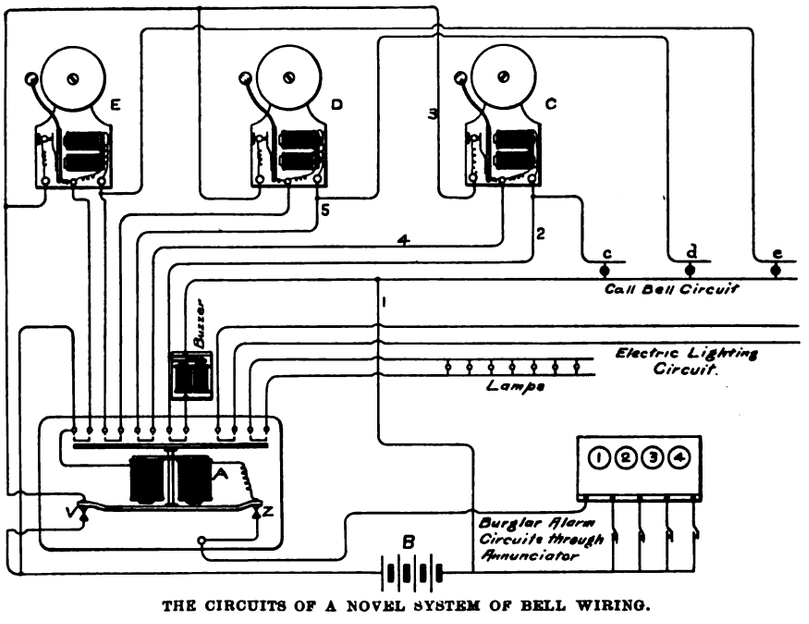
A. S. Howard,
General Manager Chicago Telephone Company.

Chicago, Ill.

## A Novel System of Bell Wiring.

*To the Editor of American Electrician:*

Sir—After having read with interest in the July number of the American Electrician, a note on "A Novel System of Bell Wiring," I wish to describe a system which I have used for several years where-




THE CIRCUITS OF A NOVEL SYSTEM OF BELL WIRING.

by all the bells may be rung together or any one may be used separately as required.

As shown in the accompanying diagram, the bells, C D E, are wired respectively as usual to the push buttons, c d e, and the battery, B. A is an electro-magnet, the armature of which carries a number of insulated contacts which when released by the closing of the burglar alarm circuit, automatically open this circuit at point, Z, and connect all the bells in series with each other, and in series with a circuit interrupter and the battery. The bells are in this combination single stroke, the make and break device on the armature of each bell being thrown out of circuit by the wires to the contacts on the armature of magnet, A. The contact, V, is closed when the armature of A is in the position shown, so that the push button circuits can return to battery through it. When working the bells in series, however, this contact must be opened in order to prevent it from short-circuiting all but bell C, when the armature of that bell is on the back contact. On the armature of A there is also a set of contacts which may be used for closing the electric light circuit if desired. With this system of bell wiring the number of wires and the number of cells of battery needed are reduced to that used in the older styles of wiring for the same purpose.

Trusting that the readers of the American Electrician may be benefited by the knowledge of such a system of bell wiring, I submit this contribution to your paper.

Bridgeport, Conn. F. M. Swalm.

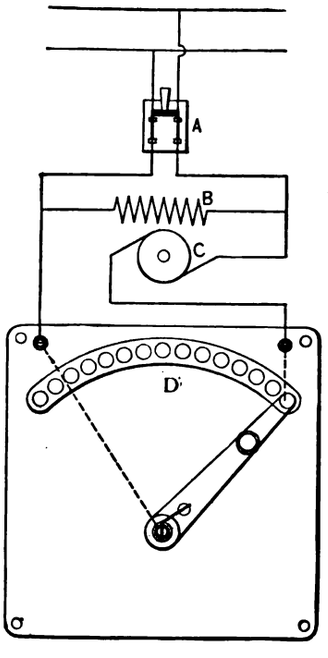
[This odd system of bell wiring gives several combinations of circuits which require considerable study to discover what course the current will take under different circumstances. Apparently when the armature of magnet, A, is in the upper position and the make and break device of the buzzer begins to act current comes from the battery through wire 1, the buzzer and wire 2 to bell C, and while the armature of this bell is against the back contact finds a return to the battery through wire 3 and the contact of bell E. As soon, however, as the armature of C is attracted the current is compelled to flow through wires 4 and 5 to bell D, and when the armature of this bell is attracted it is similarly thrown to bell E. Thus the bells apparently act in succession while the contact of the buzzer remains open. This probably explains the successful use of the same battery at times on several bells in series with each other and at other times worked independently. It would require, however, a very slow acting make and break device.—Editor.]

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# Electrical Catechism

*358. How is a shunt motor started?*

A shunt motor is generally provided with two switches, as indicated in the figure. The double-pole switch, *A*, is first closed, thus sending current through the field coil, *B*. The arm of a rheostat, *D*, is then moved slowly, so as to allow a moderate amount of current to pass through the armature, *C*. As the armature begins to revolve and to come up to speed, the resistance is gradually cut out




THE STARTING ARRANGEMENTS FOR A SHUNT MOTOR.

from the rheostat, until it is all out when the arm rests upon the last button.

*359. How is a shunt motor stopped?*

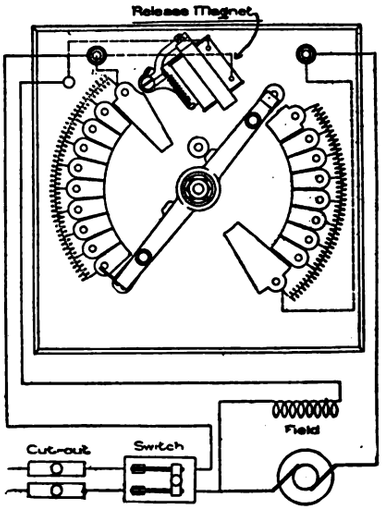
The double-pole main switch should be opened first, and as soon as the motor has come to rest, the rheostat arm should be moved back to the "off" position. If the rheostat arm is moved back first, there is apt to be vicious sparking when the last point is reached; also when the main switch is opened, there is apt to be a long arc that endangers the insulation on the field coils. Some of the automatic starting rheostats are arranged to take care of themselves so that one needs only to pull the main switch.

*360. How are automatic motor starting rheostats arranged?*

The rheostat arm carries a spring which tends to throw it back to the "off" position, also the armature of an electromagnet, whose coil is in series with the shunt field coil of the motor. As soon as the current is thrown on at the main switch, both the motor field magnet and the rheostat release magnet are energized, and the rheostat arm is magnetically held in position when it has been moved to the running position. When the main switch is opened, or the pressure is removed from the line from any external cause, the current ceases flowing around the release magnet, so that it lets go and the spring throws the arm back to the "off" position. This is called a "no-voltage" release.

*361. Why does the release magnet hold the rheostat arm after the main switch has been opened and until the motor has come nearly to rest?*

This is because the shunt motor runs in the same direction as the same machine would run as a dynamo. When the armature of the motor is revolving in the magnetic field, it generates an electromotive force just as it would if it were working as a dynamo. When working as a motor, this is in the opposite direction to that on the line, and is called a "counter electromotive force." The instant the current ceases to come from the outside source, this counter e. m. f. becomes active and sends current around through the field and through the release magnet, keeping them magnetized until the motor has fallen to a very slow speed.



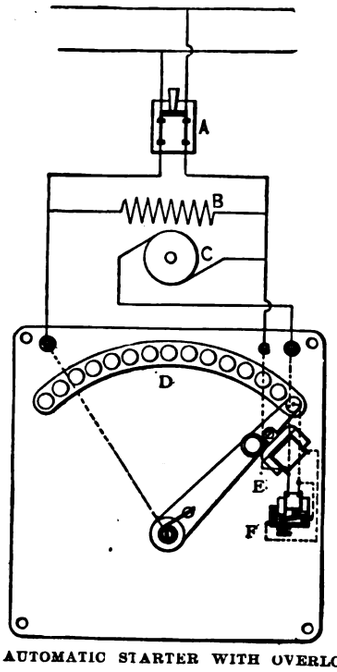

AN AUTOMATIC STARTING RHEOSTAT.

*362. How are automatic motor starting rheostats arranged to open the circuit in case of an excessive load?*

They have an auxiliary magnet whose coil is in series with the motor armature. In case the current becomes greater than is safe, the "overload" magnet lifts its armature, which either trips a spring switch in the armature or main circuit, or else short-circuits the "no voltage" release magnet, which then lets the rheostat arm fly back and open the armature circuit or leave it closed through so high a resistance that it can run only very slowly. In the figure, *E* shows the "no voltage" magnet, and *F* shows the "overload" magnet in a well-known type of starting box.

*363. What causes the long flash if the armature circuit is opened before the field circuit?*

This is caused by self-induction. When the current through the magnet coil begins to stop, the magnetism begins at once to weaken. The change in the number of magnetic lines of force sets up or "induces" an electromotive force that is in such a direction as to tend to maintain the current in the same direction and at the same strength as before; the more rapid the change in the magnetization and the larger the number of turns in the coil, the higher will be the induced e. m. f. This tends to maintain the current even through the air gap as the switch is opened. In the case of a shunt machine, the e. m. f. due to opening the field circuit is likely to be many times as great as the regular working voltage, and is liable to cause a spark to jump through the insulation and either "ground" or "short-circuit" the field coil.




AN AUTOMATIC STARTER WITH OVERLOAD RELEASE.

*364. Why is the flash prevented by leaving the armature circuit closed until after the motor has stopped?*

There are two reasons; first, because the armature offers a path of low resistance for the induced current, and, second, because the armature tends to maintain the magnetizing current until rotation stops.

*365. How does the presence of a closed circuit prevent the flash?*

When the field coil is shunted by the armature or by some other path, such as a pilot lamp, the e. m. f. of self-induction from the dying down of the magnetism causes a current to flow through the coil and around through the armature or lamp circuit; this current is in the same direction as that which came from the line, and it therefore tends to keep up the magnetization. Thus, if there is a closed circuit the induced current delays the demagnetization and so reduces the induced e. m. f.

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# Queries and Answers

Kindly inform me how I can change a 50 volt transformer so that I can raise the voltage from 50 volts to 100 volts, i. e., so that I can make a step-up transformer which will raise the voltage from a 50-volt circuit to a 100-volt circuit. C. H.

If the transformer you wish to change is fitted with two secondary coils which can be connected either in parallel for 50 volts or in series for 100 volts, it is a very simple matter to use them to transform from 50 to 100 volts without rewinding the transformer at all. This can be done by connecting the two secondaries in series for 100 volts and bringing out the middle point or common connection between the two coils; the 50-volt circuit should then be connected between this middle point and one of the outside wires and the 100-volt circuit can be taken off from the outside wires. The transformer will then be capable of transforming its rated load from 50 to 100 volts, even though half its wiring space, viz., that occupied by the primary, is idle. For instance, if the transformer is rated at 1 kilowatt it will transform 1 kw. from 50 to 100 volts or from 100 to 50 volts without overheating. If, however, the transformer is designed to give only one voltage in the secondary, a different means must be adopted. If this voltage is 100 volts, the simplest means is to find if possible the middle turn of the secondary winding and tap this out for a 50-volt terminal, connecting up the instrument as described above. If the transformer is only wound for 50 volts, the primary coils should be removed and another coil, an exact duplicate of the secondary, i. e., with the same number of turns of the same size of wire, should be put on in place of the primary. These two coils should be connected in series and the 50 and 100-volt circuits connected to them, as described above. In this case a transformer rated at 1 kw. would be able to transform 2 kw. In all cases the 50-volt and 100-volt circuits will be electrically connected to each other, but this is, as a rule, no disadvantage in such low tensions.

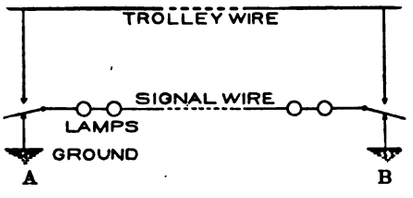
(1). Kindly let me know the system and working of signal lights at switches on single track country trolley lines.

(2). What change is necessary to make direct current motors run as dynamos, and is the machine driven in the same direction as it ran as a motor?

(3). If a direct current dynamo is built to run right-handed can it be successfully run in the opposite direction, and what changes are necessary?

(4). What operation is necessary to find size or capacity of field rheostat for direct current dynamos? W. A. L.

(1). Signal lights are generally worked on one principle whereby only one extra wire is needed between the switches. The circuits are shown in the accompanying diagram, A representing the apparatus at one end of the single track line between two switches, and B that at the other end. The special signal wire between the two signal boxes is connected through two lamps in series at each end to a two-way switch, which can be thrown up to the trolley wire or down to the ground. Normally, when there is no car on the section, both switches are down or both are up and the lamps are not lighted. If, however, a car enters from the left, both switches being down, the conductor turns the switch at A into the up position, making a circuit from the trolley and through the 4 lights and the signal wire in series and to the ground at B. The lamps thus shine until this car reaches B, when the conductor throws up the switch at that point, again extinguishing the lamps. Whenever they are lighted it is a signal preventing cars from entering either end of the line. Whenever they are extinguished a car can enter from either end, the conductor invariably reversing the position of the switch at the end entered and lighting the lamps thereby. The resistance of the signal wire in series with four 110-volt lamps absorbs the full 500 volts.




(2). A direct current shunt wound motor will run as a lynamo, with no change whatever, giving at its normal speed practically the same voltage as that which it absorbs as a motor. To obtain control of the voltage a field rheostat will have to be connected in the field circuit in the usual way. A machine will only generate current when run in one direction unless its field connections are reversed, when it must run in the opposite direction. The direction to run it to make it generate is the same as that in which it runs when used as a motor.

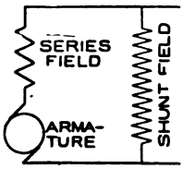
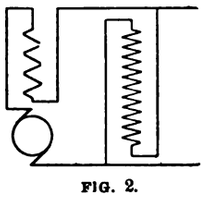


FIG. 1.


FIG. 2.

(3). A dynamo can be successfully run in the opposite direction to that for which it was built provided its brushes are radial or of any other type suitable for the reversed rotation. If not, the brush holders must be taken off and changed around in such a way as to fit the brushes for the reversed direction. All brush holders are changeable in this manner. The only change other than this is the reversal of the field magnet connections. In the accompanying diagram, Fig. 1 represents the connections for right-handed rotation, Fig. 2 represents the change necessary to adapt the machine to left-handed rotation. It will be noticed that the connections of both the series and shunt coils of the field must be changed in compound wound machines. The same change can be accomplished by simply reversing the connections to the brushes.

(4). The field rheostat of a direct current dynamo must be capable of carrying without overheating the whole of the current flowing through the shunt coils, and is usually made with sufficiently high resistance to cause a drop of 50 per cent. of the total voltage of the machine when this whole current flows through the whole rheostat. The current in the shunt field, of course, varies in different sizes of machines and varies in different makes of machines of the same size, so that no definite figures can be given for any machine without knowing its size and make. As a rule small machines lose about 5 per cent. of their total output in the shunt field, larger machines being more economical in this respect. Taking a 100-ampere 110-volt machine for example, the shunt field current would be about 5 amperes and its rheostat should have a total resistance of 8 to 10 ohms. When purchasing a rheostat the best method is to give the maker the name of the manufacturer and size of the machine. He can then decide what resistance is necessary.

We now regularly test our incandescent lamps on a photometer and with a wattmeter to see that they are of the right voltage, candle power and watts per candle. I have heard that they should also be tested to see if they are of the proper vacuum. Is this the case, and if so how should the same be carried out? W. E. J.

Yes. A lamp may show up well initially, but the vacuum is one of the most important elements of sustained candle-power and efficient life, since a slight amount of oxygen will spoil the surface of the filament and cause a great drop of candle-power. Lamps can be tested very simply in a few seconds' time by fitting up an induction coil in a dark room. The induction coil should have its secondary terminals about ¼ or ⅜ inches apart and the lamp base should be touched to one of these terminals. If there is a continued glow in the interior of the lamp the vacuum is a poor one. If there is a slight flash the vacuum is a good one. If there is no glow whatever, the vacuum is either exceptionally good or the bulb is full of air. In the latter case the lamp will soon burn out. If the filament vibrates against the glass it may give off tiny sparks, but these are no indication of poor vacuum.

What is the best manner of filling a hole between commutator bars where the mica has come out? H. A. H.

Grind up scrap mica and mix with melted shellac, not alcoholic shellac, roll into small pellets, warm these pellets until they are in a plastic condition and drive them in the hole with a short piece of wood. After the hole is filled, finish by heating with a blast lamp for an instant.

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## ALTERNATORS COMPENSATED FOR INDUCTIVE LOADS.

As pointed out in an editorial on another page of this issue, alternating-current machines whenever separately excited are poorer in the quality of regulation than shunt-excited direct-current machines. Even when the alternators are composite wound they compare unfavorably with compound-wound direct-current machinery in this respect, since they are subject to a disturbing factor, inductive currents, which is not found in direct-current machinery and which destroys good regulation in spite of the composite winding. Particularly is this the case when the attempt is made to run lights and motors from the same circuit supplied by a generator not many times larger than any one of the motors.

A line of machines has been designed and is now being built by the General Electric Company to overcome this difficulty by applying a principle of excitation and regulation not hitherto reduced to practice in this country. It is really a system of compounding, but the series currents which act to strengthen the field as the load increases are not rectified but are led into the exciter and serve to raise the voltage of that machine, which in turn delivers more current to the fields of the alternator and thus maintains its excitation and resists the demagnetizing effect of its load. The advantage of the new method lies in the fact that inductive currents exert a greater magnetizing effect on the exciter than do load currents, and thus compensate for their demagnetizing effect in the main machine.

This new principle is the invention of Mr. E. W. Rice, Jr., and is claimed by him in patent No. 595,412, issued December 14th, 1897. An explanation of its action may be given by describing one or two alternating-current phenomena.

When polyphase currents are led through suitably connected collecting rings (see Fig. 1) into an ordinary continuously-wound armature, such as that of a direct-current machine, they generate in these windings a rotary field. If the armature of a machine so supplied is held stationary this field rotates with a speed equal to the frequency of supply divided by the number of poles. If, however, the armature is rotated in the opposite direction with exactly the same speed the field set up (still rotating with respect to the armature) remains stationary in space. The position which the field thus induced will assume relative to the pole pieces depends upon the angle between the coils of the armature and the coils of the generating machine supplying them.

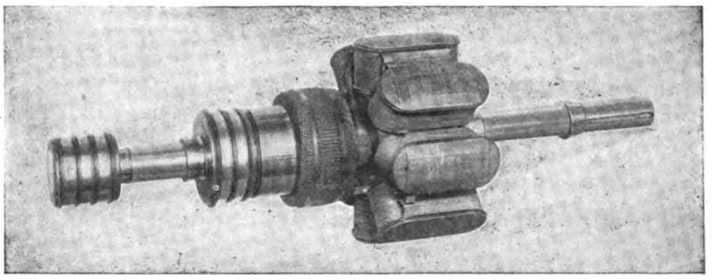


FIG. 3.—THE ROTOR OF A COMPENSATED REVOLVING FIELD MACHINE, SHOWING THE EXCITER ARMATURE AND COLLECTING RINGS.

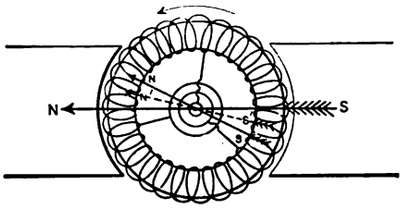



FIG. 1.—DIAGRAM OF MAGNETIC FORCES, ILLUSTRATING HOW LAGGING CURRENTS BOOST THE EXCITER OF A COMPENSATED FIELD GENERATOR.

If the armature of a direct-current machine is rigidly rotated in the direction of the arrow shown in Fig. 1 so that polyphase currents brought into it through the collecting rings set up an armature polarity, n s, as shown, this will serve to strengthen somewhat the main field, N S, of the same machine. If now for any reason the polyphase currents entering become subject to a greater inductive influence, causing them to lag, i. e., to rise and fall later with regard to the rotation of the armature than they previously did, the magnetism set up by the armature will assume the direction of the dotted lines, n' s', and will more materially assist the main field, N S, than did the previous magnetism, n s. This is the principle embodied in the machines above referred to for causing lagging alternating currents to increase the exciter voltage.

The machine shown in Fig. 1 is the exciter of an alternator and the polyphase currents brought in through the collecting rings shown are derived from the outgoing currents of the alternator by means of series transformers so that as the load of the alternator increases these currents increase and thereby give a boosting effect, n s, to the exciter field, while if the main currents lag this boosting effect is twisted around into the direction, n' s', where it still further assists the exciter field and thereby indirectly compensates for the demagnetizing action which such lagging currents exert in the armature of the alternator itself.

One of these machines, completed, is shown in Fig. 2, in which there may be seen a small direct current armature immediately under the front cover plate, a commutator and two collector rings to the left of it and three more collector rings on the extreme end of the shaft overhanging the bearing. The armature and commutator are those of the exciter, its fields having the same number of poles as those of the alternating generator itself and being enclosed immediately under the swell of the cover plate. The arrangement of the parts is made still more clear by Fig. 3, which shows the rotating element of the machine removed. Here the outwardly pointing poles of the rotating field alternator are clearly shown to the

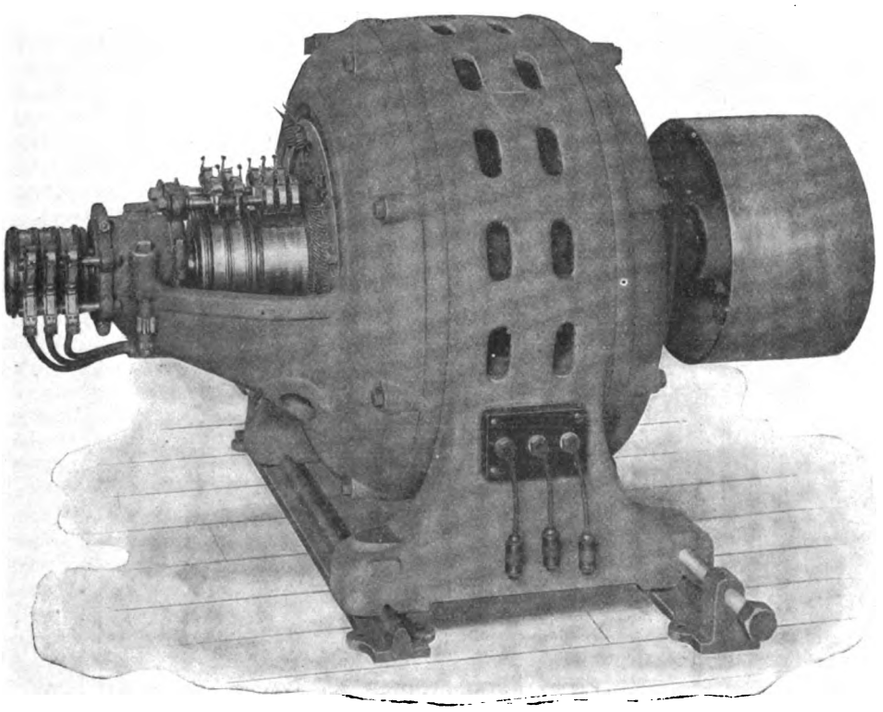


FIG. 2.—A 75-KW. 60-CYCLE, 8-POLE, 3-PHASE COMPENSATED REVOLVING-FIELD ALTERNATOR.

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right; next to them, toward the left, appears the rotating armature of the exciter, with its commutator immediately adjacent to it, and to the left of this commutator are two collector rings which carry the direct current into the main rotating-field coils of the alternator. To the extreme left are three collector rings, which are tapped into the armature winding of the exciter for the purpose described above.

The connections of these parts are shown in Fig. 4, which illustrates diagrammatically the various circuits of a complete three-phase machine. To the extreme right are shown three series transformers through the primaries of which passes the main output from the armature of the alternator. The secondaries are Y-connected at their upper terminals, their lower terminals leading to the three small collector rings represented at the extreme left of the diagram, and actually at the extreme left of the machine, as shown in Fig. 3. Through these collector rings the currents from the small series transformers are carried in to the three points in the armature winding of the exciter, 120 magnetic degrees apart. In this armature they set up a rotary field which, because of the synchronous rotation of the armature in the opposite direction, becames stationary and reacts upon the exciter field as pointed out above.

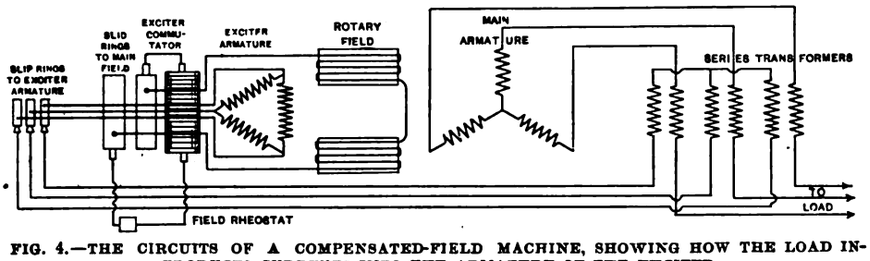



FIG. 4.—THE CIRCUITS OF A COMPENSATED-FIELD MACHINE, SHOWING HOW THE LOAD INTRODUCES CURRENTS INTO THE ARMATURE OF THE EXCITER.

This reaction boosts the regularly generated shunt field of the exciter, this boosting varying, as pointed out above, with the magnitude and lag of the main load.

From the commutator of the exciter direct current is led to the large collector rings, through which it is introduced to the main rotating field, the usual field rheostat being inserted in one side of this connection.

Machines so far developed of this type are of moderate size and belt driven, such machines being more severely taxed by the loads of induction motors of ordinary sizes than are larger direct-coupled generators. The application of the new principle allows a considerable reduction of the weight below that even of composite-wound machines of the same capacity, since the ratio of field to armature ampere turns can be reduced without sacrificing regulation, and the weight of material in the field can be reduced in consequence. For instance, one of the new compensated revolving-field alternators, with a capacity of 100 kw., delivering 60 cycles at a speed of 900 r. p. m., weighs 6800 pounds, while a composite-wound revolving-armature machine made by the same company for the same frequency at the same speed, but rated at only 90 kw., weighs 7720 pounds.

## THE HEATING AND VENTILATING SYSTEM OF A LARGE TELEPHONE EXCHANGE.

The necessity of reducing so far as possible the dust entering the operating room of a telephone exchange and settling on the enormous number of contacts of the switchboard, combined with the care

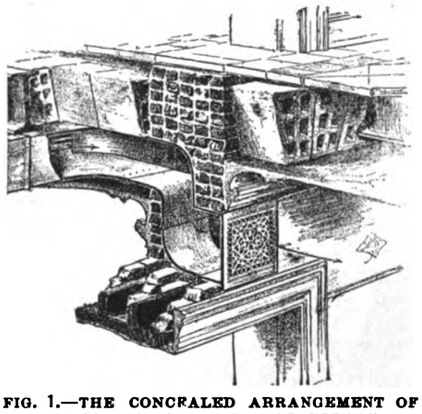


FIG. 1.—THE CONCEALED ARRANGEMENT OF THE AIR PASSAGES IN A FIREPROOF STRUCTURE.

which telephone companies find it advisable to exercise over the sanitary conditions surrounding their operators, renders the ventilating and heating system of an exchange a more serious problem than that of any other structure.

The Central Bell Exchange on Milk Street, Boston, is one of the models in this respect. The incoming air is drawn down from above the roof line by a shaft at one corner of the building, which shaft is provided with special filters for removing the dust. The air is then heated in the usual way by coils of steam pipes in the basement and blown by the fan into another vertical flue rising next the elevator shaft to branches on each floor.

The floor heights being ample in this building, there was introduced just beneath the ceiling over each floor a complete horizontal distributing system of galvanized iron pipe. The layout of this horizontal distributing system for one floor is shown in Fig. 2. While the velocity of the air in the vertical flue is high it becomes less in the horizontal mains and still less in the branches to the registers, so that the air leaves the latter at a velocity too low to cause noticeable drafts. The flues being carried under the floors and opening directly out into the rooms, the distribution is what is called overhead, the air entering warm and fresh at the top of the rooms.

The finely finished interior of such a building naturally demands that no piping be exposed to view. The corridor ceilings, therefore, over which the horizontal distributing mains run, are finished below the pipes the full width of the corridors, making thereby a false ceiling a little below the level of that of the adjoining rooms. The entire system is thus rendered completely invisible.

The arrangement of the overhead duct and its branches is clearly indicated in the illustration, Fig. 1, which shows a broken section through a partition wall and floor. The fireproof construction is evident, the building having a steel frame with hollow-tile floor arches. The registers are placed directly over the doors, and, being in interior walls, the air circulates across the rooms and toward the windows on the opposite sides.

The system was installed by the B. F. Sturtevant Company, Boston, Mass., from whose comprehensive treatise on "Heating and Ventilation" the description and the illustrations above have been taken.

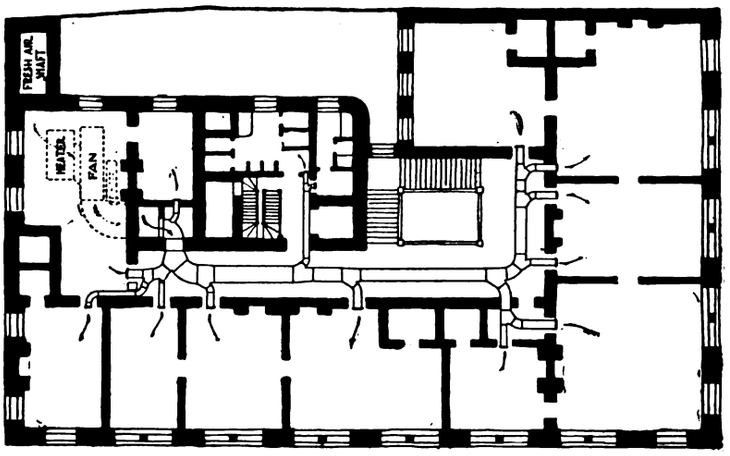



FIG. 2.—THE PLAN OF ONE FLOOR OF THE BOSTON BELL TELEPHONE EXCHANGE, SHOWING THE COURSE OF THE AIR DUCTS.

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## VITRIFIED CLAY CONDUITS FOR UNDERGROUND ELECTRIC WIRES.

Ever since electricity became a recognized factor in commercial affairs, there has been a growing demand for an efficient underground construction that would protect the insulated conductors from outside influences and serve as a permanent structure into which they might be drawn or from which they might be removed without disturbing the surface of the street.

What more natural than that attention should be turned to that most common mineral, clay pottery, one as nearly indestructible as any known to man, as witnessed by the samples that were made in the earliest times of prehistoric men but which come down to us as fresh and unaltered by the centuries of exposure as they were when made.

As it was natural to turn to pottery for a material, it was equally natural that some of the existing clay working establishments should recognize this new market for their product and begin to turn their attention to the requirements in this line. Among the first to do this was the H. B. Camp Company, whose works are located at Aultman, Ohio, not many miles from Akron, which is the center of the extensive pottery industry, being in the region of extensive clay deposits.

The prevailing form of the Camp vitrified conduit is an eighteen-inch single duct length, the bore being circular and full three inches in diameter with the ends well reamed, to provide for registration when laid. The outside is square with corners chamfered off, each face being 4¼ inches wide and beaded lengthwise. Special sizes, however, are made and multiduct sections when ordered.

The work is carried on in two factories, which are about one-eighth of a mile apart, and in the vicinity of extensive clay banks from which the material is mined. Factory No. 1 has a capacity of from thirty to fifty tons of finished material per day, and No. 2 about 150 tons. The clay for No. 1 factory is obtained by surface mining, while that for No. 2 is mined from two tunnels that penetrate several hundred feet through the vein beneath the surface.

This vein is capped by an eighteen-inch vein of bituminous coal, while just above, about one hundred feet, is a five-foot vein of coal, from which is mined sufficient fuel for firing the kilns, making a very interesting fact that the fire-clay and coal in sufficient quantities to bake the clay are mined from the same bank.

From the tram cars the material is dropped into chutes and led directly into the dry pans, in which it is ground to a fine powder. These pans are about nine feet in diameter, the bottoms being of cast iron and perforated so that the material sifts through as soon as it is fine enough. The pans are revolved rapidly by means of a central vertical shaft and the pulverizing is accomplished by means of two heavy wheels held in horizontal position on a shaft, one on each side of the vertical shaft, and so attached that they move back and forth as they turn on their bearings, so as to cover the entire surface of the revolving pans. After being pulverized the material is elevated by means of bucket conveyors to the upper floors of the factory, where it is bolted, when the fine powder is delivered to bins and the coarser or unground lumps led back by means of chutes to be reground.

The tempering or moistening and kneading process follows and this is accomplished by different methods in the two factories. In factory No. 1 the pulverized material is delivered to large revolving cylinders about six feet in diameter, which rest on rollers, and, when caused to revolve, bring the material against a mixer which is attached to a shaft leading into the cylinder, water and steam in sufficient quantities being admitted to the cylinders as the process goes on. At the second factory, however, the tempering mill is like the grinding mills, the pulverized material being admitted from a chute, when an attendant directs a stream of water from a suitable pipe and watches the process and tests the mass by his hands, to determine when of a proper consistency. When suitably tempered the contents of the pan are scooped out by means of long shovels which are filled by the revolution of the mass, when it is dumped into a hopper and again elevated ready for the presses or for the forcing process.

Two types of steam presses are employed, some being vertical and others horizontal. Each consists of a steam chest about 44 inches in diameter, in which a steam pressure of about 115 pounds is employed. The piston rod is extended and carries a second smaller piston which travels in a cylinder having an opening on the upper side at one end; into this the plastic mass is directed from the chutes, after which the piston forces it into the closed end of the cylinder and the material emerges through a pair of dies at the outer end in two continuous streams, being each perfectly formed conduits, which are cut off in suitable lengths by means of wires. The ends of the tubes are then beveled off by means of a hand reamer and the sections are carefully placed on end, close together, on small platform cars which run on trucks that carry them to the drying chambers, where they are left until sufficiently dry. The time required for evaporating the moisture depends upon the condition of the atmosphere, and is usually four or five days.

After drying, the conduits are taken to the baking kilns. These are the ordinary dome down-draught kilns lined with fire brick and strengthened by means of numerous iron bands, the furnaces being arranged at suitable intervals in the outer walls of the kiln. The conduits are placed on end and piled in lengths one above the other until the entire space is occupied, when the fires are lighted, the soft coal above described being employed as fuel, and the temperature is raised to a very high degree, by stages, and then gradually reduced, the door and all openings being carefully sealed with clay. At a proper stage of the process common salt is placed upon the fires, the fumes from which serve to glaze the surface of the conduits both inside and out, rendering them smooth and practically impervious to water. The process of charging, burning and emptying a kiln occupies from four to five days, some times as high as eight, depending upon the material.

On removing the sections from the kiln they are either loaded for shipment directly on cars which are brought in on sidings along the line of the kilns, or the material is piled in great quantities in the yard, where it awaits shipment. Usually, before shipping, the inner surface is smoothed by means of a peculiar shaped scraping tool.

The Camp works were established about ten years ago and were first engaged in the manufacture of ordinary red brick, then drain tile became the principal product, after which sewer pipe was manufactured in great quantities, when electric conduits became the chief product, and on these the works are now running, although large quantities of porous floor brick are manufactured, which serve as flooring material for large office fire-proof buildings. The works are operated under the direction of H. B. Camp, who designed and built the principal machinery, and Mr. Wm. Weaver, who is superintendent and general manager of the works.

The permanence or value of clay products depends chiefly on the way in which the chemical changes are brought about during burning and the proper temperature to which the clay is subjected, and this feature should be carefully considered by all purchasers of clay products, especially those designed for underground conduit work. If, in the process of burning, only sufficient heat has been applied to drive out the water of hydration, the resulting material will be porous and friable and will crumble under the action of frost on account of its porosity and attraction for moisture. By carrying the heat above the point to expel the moisture the clay will be found to continue to shrink and grow more hard and dense and more impervious to water until finally, if stopped at the right time, the mass will have become practically impervious and very hard, strong and tough. In this condition the material is a new chemical compound, forming an indestructible mineral. If, however, the heat be continued above this most favorable point the clay begins to deteriorate in some of its qualities. There is a difference, however, in clays; some only require to be made moderately hot, while others require the highest temperature attainable in metallurgic practice. From the above it is apparent that purchasers of products of this description should know the quality of the material and that reasonable care and skill has been exercised in the manufacture of the same.

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# New Apparatus and Appliances

NEW SIEMENS & HALSKE APPARATUS.

As noticed in the last issue of the American Electrician, the Siemens & Halske Electric Company of America has greatly broadened the field of its operations and taken up the manufacture of many new lines of apparatus at its works in Chicago. A description of some of this newly developed apparatus may prove of interest here.

An instrument new to the works of this company, although in a slightly different form quite familiar to the trade, is the alternating current integrating wattmeter illustrated in Fig. 1. This is the design of Mr. Thomas Duncan and resembles in its general construction the meters of the same design formerly made by the Fort Wayne Electric Corporation.

The new instrument shown in Fig. 1 is known as the improved Duncan meter. The shape of this instrument has been made higher and narrower, the impedance coils being placed in a separate sheet-iron box on the back. The convenience of hanging is greatly improved, and the case is attached to the frame with a hinge and screw, forcing it against a rubber gasket, rendering it dust proof. The meters are direct reading, with no constant, in all sizes up to and including the 100-light size, the details of the internal construction being practically the same as those

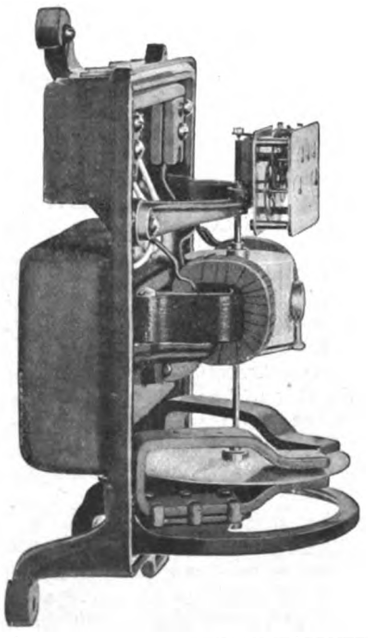


FIG. 1.—THE IMPROVED DUNCAN WATTMETER

of the older Duncan meters. In addition to the ordinary single-phase alternating meters, Mr. Duncan is developing a complete set of polyphase and direct current indicating, integrating, recording and switchboard meters, as well as ampere hour meters for both alternating and direct currents.

Another new line is that of enclosed arcs, one of which is shown in Fig. 3. This is a direct current type of high grade design, embodying a concentric coil operating a lava roller clutch acting on the carbon. The outer globe is fitted with a hole at the bottom, through which the inner globe can be lowered for trimming. This lowering also opens the circuit.

Of the 2000 automobile motors men-

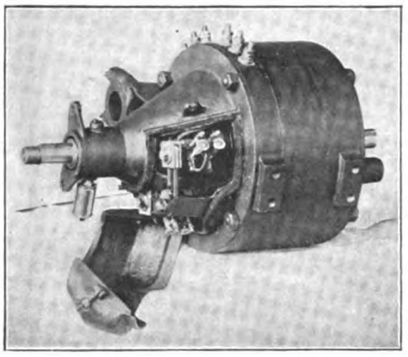


FIG. 2.—AN AUTOMOBILE MOTOR.

tioned in the last issue of the American Electrician one is shown in Fig. 2. These motors are designed to run continuously with an output at 4 h. p. and a rise of temperature not exceeding 40° C. In order to secure maximum output and efficiency

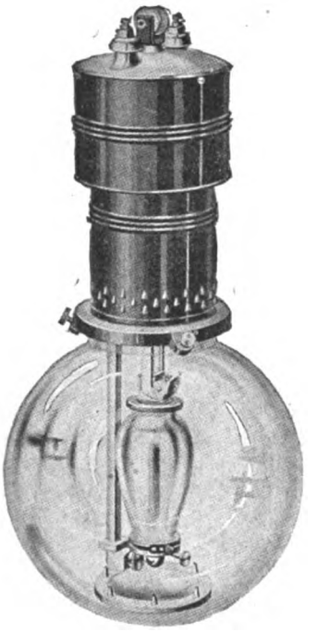


FIG. 3.—A NEW ENCLOSED ARC LAMP.

with minimum weight the entire field structure is made up of laminated iron. They are fitted with radial brushes of the type designed by Mr. A. Churchward and used by him on the motors and generators of the Excelsior Company two years ago.

A LINE OF ENCLOSED MOTORS.

The chief objection to the enclosed motor as ordinarily made is the trouble that may occur with the commutator due to worn out brushes or any other derangement, which trouble is not observable until it becomes so serious as to interfere with the motor's operation.

The Western Electric Company, Chicago, has brought out a line of "encased" machines (see Fig. 4), as the company prefers to call them, in which this objection is met by providing mica windows in the cover plates on the commutator end of the machine. The same motors may be used with these cover plates removed, in which state they are styled "semi-encased" machines, and they will, when so used, deliver a higher output than when entirely encased. For instance, a motor weighing 1300 pounds and running at 700 r. p. m., is rated at 10 h. p. with the covers off and only 7½ h. p. when entirely encased.

Both the magnet frames and the magnet cores of these motors are made of cast steel, the cores being bolted to the yokes. The end brackets supporting the bearings are fastened to the circular frames by four screws equally spaced around the circle, so that by taking out these screws and rotating the brackets either a quarter, a half or three-quarters of a turn, the self-oiling bearings may be brought right side up with the motor supported in any position; upright on the floor, inverted on the ceiling or bolted to a wall or column.

These motors are wound with either shunt or series fields or are compounded in two different ratios, one entitled "quarter compound" and the other "half compound." The term "quarter compound" signifies that one-quarter of the total volume occupied by the field coils is used for the series winding, the other three-quarters containing the shunt winding. This ratio of coil sizes gives a speed variation of about 15 per cent. between no load and

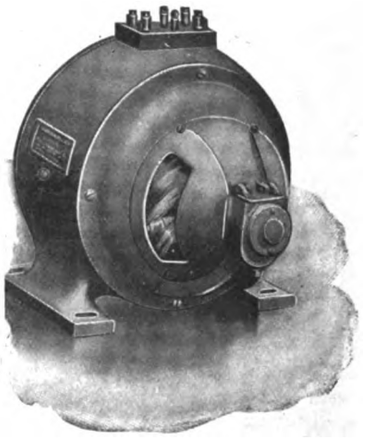


FIG. 4.—THE WESTERN ELECTRIC "ENCASED" MOTOR.

full load. In the "half compound" machines the series coils occupy about 50 per cent. of the total volume of the field windings. These motors drop about 40 per cent. in speed from no load to full load. The first machines are, of course, desirable where a nearly constant speed is desired, and the second where highly fluctuating loads are encountered and corresponding fluctuations of current are undesirable in the electric circuits.

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### A PARALLEL MOTION BRUSH HOLDER.

One of the disadvantages of the ordinary form of brush holder in which the brush rocks around the rod supporting the holder is that its point of contact with the commutator is constantly changing. As the commutator surface rises and falls, due to slight eccentricities, the brush rocks back and forth, making contact at one instant under its leading edge and at the next instant under its following edge. This difficulty is overcome in the reaction brush by making its movement a sliding one, but at the expense of losing the tightly clamped construction by which the current is readily carried from the brush to the holder.

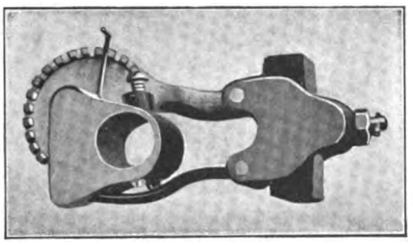


FIG. 5.—AN IMPROVED BRUSH HOLDER.

An arrangement designed by Mr. W. K. Bassford, Jr., for use on the generators built by the American Engine Company, Bound Brook, N. J., is illustrated in Fig. 5. It will be seen that in this case the brush is clamped in a holder which is supported on two links forming a parallel motion, so that as the holder rises and falls the face of the brush remains in parallel planes tangent to the commutator. The tension spring and adjusting device are of the simple and easily locked style common in reaction brush holders.

### AN ELECTRICAL SOUVENIR OF THE DEWEY CELEBRATION.

Fig. 7 shows an application of the electric scarf pin and pocket storage battery to souvenir work, the lamp being covered

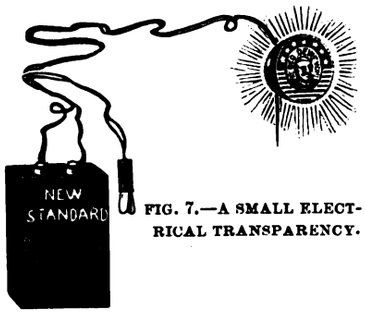



FIG. 7.—A SMALL ELECTRICAL TRANSPARENCY.

with a transparency in this case of Admiral Dewey. The combination was devised by Mr. Wm. Roche, New York City, for the recent Dewey celebration.

### A MOTOR DESIGNED FOR DIRECT GEARING TO MACHINE TOOLS.

The illustration, Fig. 8, shows a 28-in. swing screw-cutting engine lathe driven by the Bullock type N motor. As will be seen the motor is placed directly on the spindle in the head-stock, taking the place of the cone pulleys. The armature spider is built directly upon the hollow spindle of the lathe.

By means of a new system of variable speed control, the motor is given a greater range of speed, without loss of torque, than is ordinarily given by the cone pulley, having sixteen speeds in either direction, including the back gear. The controller is placed upon the leg of the lathe directly under the head-stock, and is operated by a splined shaft running along the bed of the lathe, and a handle which travels with the carriage. The slowest speed is 60 and the highest about 250 revolutions.

The motor is fully described in bulletin No. 0435, which may be had by addressing the Bullock Electric Manufacturing Company, Cincinnati, O.

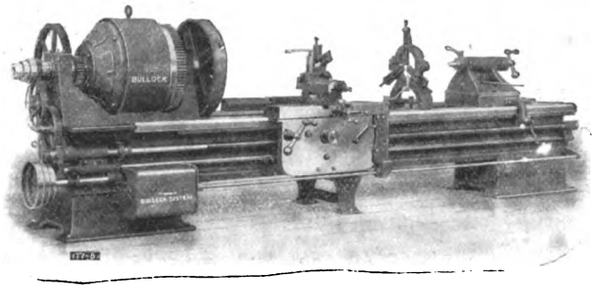


FIG. 8.—A SPECIAL TOOL MOTOR.

### SOME SMALL ELECTRIC SPECIALTIES.

Fig. 9 shows a receptacle for miniature lamps, with Edison bases, made by the H. E. Plass Electrical Supply Company, New York City. The base of the receptacle is of porcelain and the insulating material between the terminals is mica, so that it is fireproof and well adapted to exposed locations. The same illustration shows a miniature lamp made by the same company in two forms, one with a hook, making of it a watch charm and the other in scarf pin form.

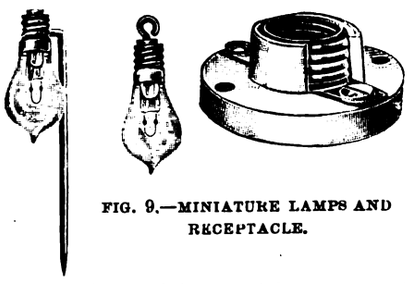


FIG. 9.—MINIATURE LAMPS AND RECEPTACLE.

### A VARIABLE SPEED MOTOR.

The customary methods of reducing the speed of a direct current motor on constant potential supply are to insert resistance in the armature circuit or to strengthen the field. The first is wasteful and does not give a definite speed regulation. The second is more economical of power but requires a large and expensive motor in order to get sufficient field strength for the very slow speeds. It also leads to trouble at the high speeds through not having sufficient field strength to saturate the poles, and therefore to give a proper commutating fringe of magnetism.

Mr. F. A. Johnson has patented a means of overcoming this difficulty by a device which is embodied in a motor now built by the Stow Manufacturing Company, Binghamton, N. Y., one type of which is shown in the skeleton illustration, Fig. 10. In this motor the field strength is varied to give the desired change of speed. The variation is not accomplished by changing the exciting current, however, but by changing the magnetic reluctance of the path of the field magnetism. This is accomplished by mechanically moving up or down a plunger, shown in the illustration, which forms the central and main part of one of the poles of the motor. Surrounding this plunger is a shell which, even when the plunger is moved to its upper limit, conducts some magnetism to the pole, giving sufficient field for the highest speed. Owing to the fact that this field does not come down the center of the pole, but at its edges, it is concentrated at the pole tips, where it is needed for giving the proper reversing tendency to the current in the coils as they pass under the brushes. Thus the movement of the plunger up or down, varying as it does the reluctance of the magnetic circuit and thereby changing the field strength, and with it the speed of the motor, does not alter materially the strength of the field just under the tips of the pole, thus giving good commutation at all speeds. In the motors, as made under this design, the upwardly extending rod from the plunger is screw threaded and fitted with a hand wheel for moving it with ease and giving it fine adjustments.

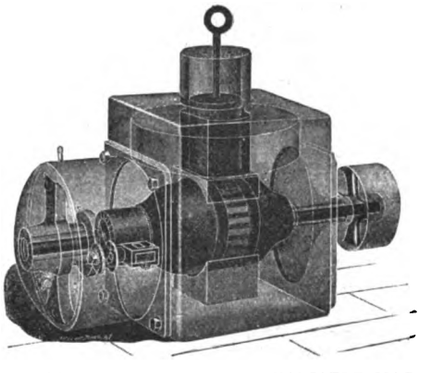


FIG. 10.—A MOTOR WITH A VARIABLE MAGNETIC CIRCUIT.

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A BATTERY VOLTMETER.

Fig. 11 shows a voltmeter of the pocket watch-case style, the scale reading from zero to 3 volts in one-tenth volt divisions, designed for the indication of primary and storage batteries. The instrument is not polarized and will read when connected to the circuit in either way, thus saving



FIG. 11.—POCKET VOLTMETER.

considerable time when connecting up. It is not readily burned out and its parts are designed to stand considerable abuse so that the accidental connecting of eight or ten cells is not liable to injure the instrument. It is made by the Eldredge Electric Manufacturing Company, Springfield, Mass.

AN INTEGRATING STEAM ENGINE INDICATOR.

For the constantly varying loads of steam engines in electric light, and particularly in street railway service, the ordinary indicator gives records on which but little dependence can be placed when the attempt is made to determine the coal or water consumption or any other factor per indicated horse power hour. No matter how frequently the cards are taken, up to the capacity of the operator, it is hard to get a real average unless the length of the test is prolonged and the number of cards is enormous, entailing a great amount of planimeter work and the liability of error in tabulating the results. On this account an instrument which would automatically measure the amount of work done during each stroke and add this work to a record on a dial, so that by simply taking readings at five-minute or other intervals the number of horse power hours delivered by the engine between readings could be determined at sight, would prove a valuable appliance in power house testing.

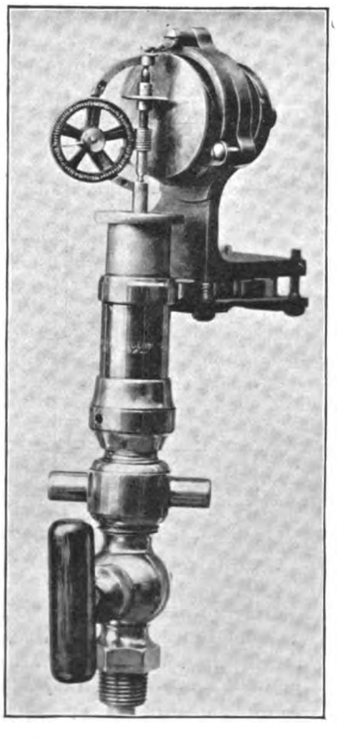


FIG. 12.—A HORSE-POWER-HOUR RECORDING DEVICE.

Several such instruments have been designed, notably abroad, but by far the neatest and simplest that has come to our attention is one devised by Mr. Benj. H. Blaisdell, Chief Engineer of the Charlestown Power Station of the Boston Elevated Railway Company. This instrument in its most improved form is shown in Fig. 12, from which it will be seen that the pencil mechanism of the ordinary indicator is replaced by a part of the recording mechanism fastened to the end of the piston rod of the indicating cylinder. This frame supports a hardened steel spindle mounted between cone centers. The spindle has secured to it a friction roller and worm, the latter engaging a pair of light worm gears also supported by the frame. One of these has 100 teeth and carries a graduated scale, while the other has 99 teeth and carries a pointer traveling over this scale. Clamped to the arm of the indicator which usually supports the paper drum is a bracket carrying a circular disc placed in a vertical plane. This disc is rotated back and forth by the usual reducing motion from the engine cross-head just as is the paper drum on the ordinary indicator, while a small helical spring serves to press the disc with a light contact against the roller on the piston rod frame.

The adjustment of the instrument is such that at atmospheric pressure the roller bears against the center of the disc and any rotation of the latter will not cause any movement of the roller. As the roller rises, however, due to steam pressure under the indicator piston, it will receive a motion of rotation proportional to the product of the steam pressure and the speed of the cross-head of the engine. On the return stroke the roller will be turned back if there is back pressure in the cylinder or will be turned further forward if there is a vacuum in the cylinder. Thus the angle turned through by the roller during any time interval will be proportional to the work done during that time, and the work done by the engine will thus be shown at all times on the graduated scale. A constant can be readily obtained for the instrument so that the scale reading can be reduced to horse-power hours and divided by the time to average horse power without the usual labor with the planimeter, the deduction of mean effective pressure, etc.

The instrument has given good results under test and will no doubt be found useful by those desiring the highest economy in engine running.

FEED WATER HEATERS AND PURIFIERS.

For steam plants located in districts where the feed water contains much lime or other impurities insoluble in hot water, no auxiliary appliance is more important than a feed-water purifier. Purifiers for such cases are very simple in principle, as they need only consist of feed-water heaters, the impurities being rendered insoluble by the heating and being deposited in the heater instead of in the boiler.

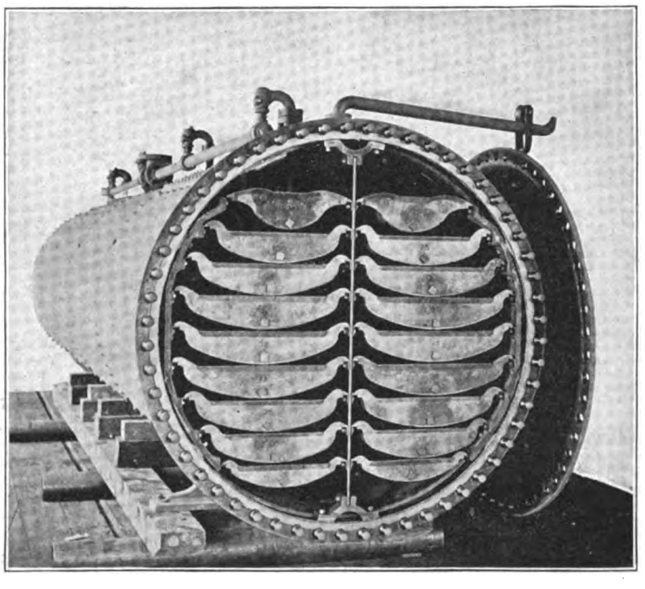


FIG. 13.—A FEED-WATER PURIFIER SHOWING PANS.

A purifier of this type, made by the Hoppes Manufacturing Company, Springfield, Ohio, is illustrated in Fig. 13, this being a live-steam purifier, the feed water being pumped into it under full boiler pressure, live steam surrounding the feed water and heating it up to the temperature

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of saturated steam at full boiler pressure.

A very similar machine is made by the same makers for utilizing the thermal energy remaining in exhaust steam to heat up the feed water to 210° F., this heater resembling the purifier shown in the illustration, but having in addition an oil eliminator to prevent the cylinder oil from being returned to the boiler and a water-level regulator of the float-valve type to maintain the proper level of hot purified feed water in the bottom of the heater from which the pumps draw and feed the boilers.

The structure of the purifier shown in Fig. 13 consists of a boiler shell within which, supported by suitable ledges, is a series of shallow pans made of steel plate. These pans are so designed that when the feed water is led into the top pan it flows over the ledges in a thin film and adheres to the under side of each pan until the lowest point is reached, when it drops into the next pan, and so on to the bottom of the shell. Steam is admitted directly from the boiler in the live steam purifier and from the exhaust in the feed-water heater, heating up the thin sheets of water on the under sides of the pans, causing the water to cease acting as a solvent for the impurities which are then deposited on the pans much as are stalactites in natural caves. By removing the head of the shell the pans can readily be taken out, cleaned and returned. The head is bolted on over asbestos packing and for its removal there is provided a swinging arm or crane fitted with a trolley by which the head may be swung out of the way without the application of great force.

The live steam purifiers are made in sizes up to 1000 h. p., this size being 5 ft. in diameter and 24½ ft. in length. The exhaust-steam heaters are made up to 5000 h. p., the dimensions of this mammoth size being 68½ ins. in diameter by 26½ ft. in length.

### A SPECIAL STEAM SEPARATOR.

The accompanying cut, Fig. 14, shows a special Sweet's separator of which two are being made for the New Jersey Zinc Company by The Direct Separator Company of Syracuse, N. Y. The separator is arranged for a side inlet and top outlet and in operation is similar to the standard machines of the same make—that is, the water running along the bottom of the horizontal pipe is caught by the projecting cone A and carried back of the lining to the water chamber. The steam surrounding the central pipe B leaves more or less water adhering to its surface and this moisture traveling downward is caught by the projection C and carried through the pipe D to the water chamber. The steam in passing downward is brought in contact with separating surfaces E and F, which conduct the little particles of water from the steam current and keep them from further contact with it.

By reversing the direction of the steam current any moisture yet remaining is thrown downward to the water chamber.

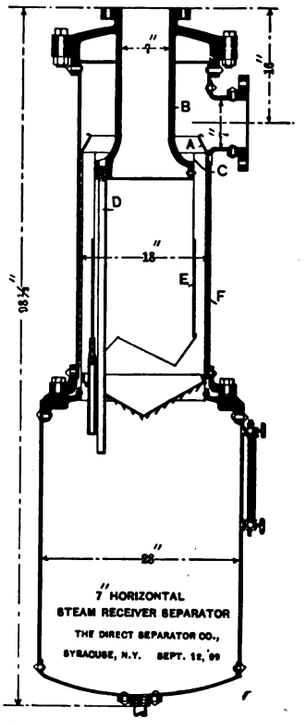



FIG. 14.—A SPECIAL RECEIVER SEPARATOR.

The separators are each made of two welded steel tubes, with flanged steel

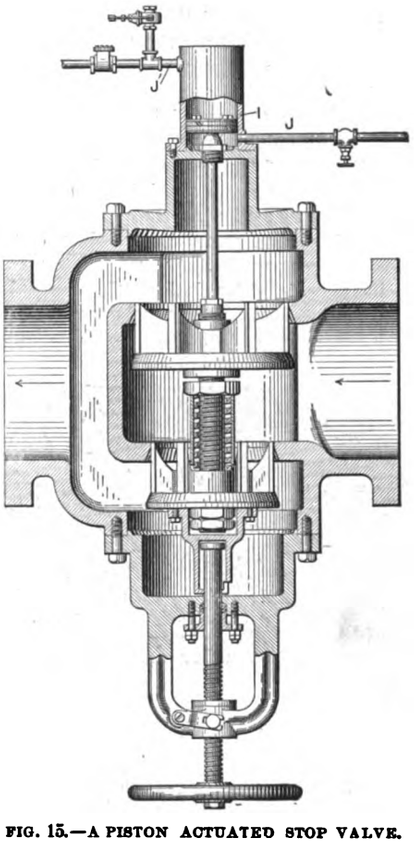



FIG. 15.—A PISTON ACTUATED STOP VALVE.

head, arranged for parting in the middle, as shown, designed for a working pressure of 150 lbs. per sq. in. The linings are of heavy gage cold rolled copper, and the other structural points will be understood from the drawing.

### AN AUTOMATIC STOP VALVE.

For the purpose of cutting off the steam from main pipes or headers in case a break occurs, several automatic valves have been designed in which the movable parts are carried to their seats by the increased rush of steam past them. Such valves must be carefully adjusted so that they will not close when the rush of steam is simply that of an overloaded engine and they are likely to stick just when most wanted.

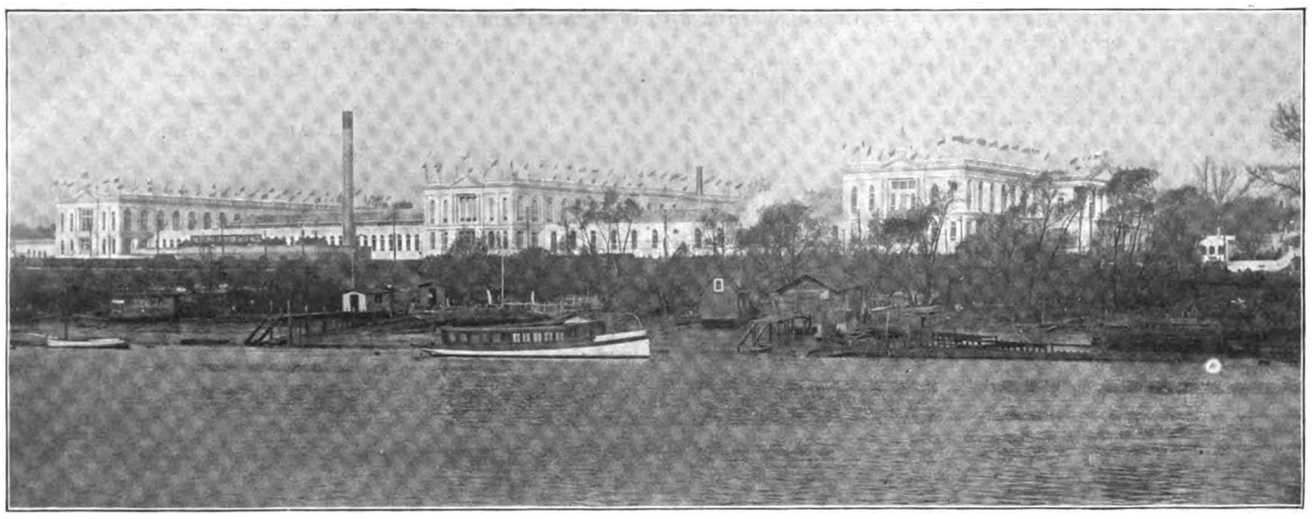
The valve shown in Fig. 15, made by the Locke Regulator Company, Salem, Mass., depends upon another principle, viz., the drop of pressure between the boilers and the distant end of the steam line, such as the throttle. This difference of pressure is introduced into an auxiliary steam cylinder within the valve, the piston of which operates the main valve. The cylinder is shown at I in the upper part of the illustration, the pipe, J, coming from the boiler and the pipe, J', communicating with the other end of the steam line. The valve proper is of the balanced type, and, so long as there is no material drop of pressure in the steam line, remains in the open position owing to the force of gravity. As soon, however, as any break or other accident occurs, occasioning a considerable difference of pressure, the piston in cylinder, I, is forced upward, closing the valve with it. The valve can also be either opened or closed by means of the screw and hand wheel at the bottom, this screw being normally left in such a position that the valve discs are free to move from their open to their closed position. This makes it a convenient hand cut-off, taking the place of the ordinary valve in the main pipe. The valve stem is kept in alignment by means of wings on the valve seats, and a powerful spring is provided to give a relative movement between the two discs so that both may, under all circumstances, come up firmly to their seats.

## NEW BOOKS.

Construction and Repair of Commutators. By L. C. Sharp. Omaha, Nebraska: Published by the author; 31 pages. Price, $.50.

This little paper-covered reference book is intended for machinists and others who have to work with commutators in ordinary shops and desire handy rules based on the results of practical experience. The book discusses the complete construction of a commutator from the segments and sheets of mica to the finished apparatus, telling and illustrating by sketches how to straighten the segments, cut the insulation, build it to gage, assemble the parts in the compressing ring, burn out the shellac, turn to size, bake and test.

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# THE NATIONAL EXPORT EXPOSITION.

During the year that has passed since the close of the war between the United States and Spain this country has virtually adopted a policy of territorial expansion which has induced a most remarkably widespread and powerful tendency toward industrial expansion. Not only have American manufacturers become alive to the possibilities of trade in the new territory brought under the protection of the Stars and Stripes, but the field which they covet has extended to much wider boundaries, and efforts such as belittle any previous attempts in the same line are being made to encourage orders from the countries of South America and the Orient as well as of Europe itself. Most timely, therefore, is the opening of an exposition unique in history in that it aims to display the products of American manufacturers for export.

The National Export Exposition which was opened on September 14th in grounds located in West Philadelphia, immediately adjacent to the University of Pennsylvania, and which will remain open until November 30th, is under the combined auspices of the Philadelphia Commercial Museum and the Franklin Institute. The purpose of the Museum is the same as that of the Exposition, viz., to promote export trade of American products, while the Franklin Institute has had experience with some thirty previous exhibitions, which experience has been a large factor in aiding the success of the present one.

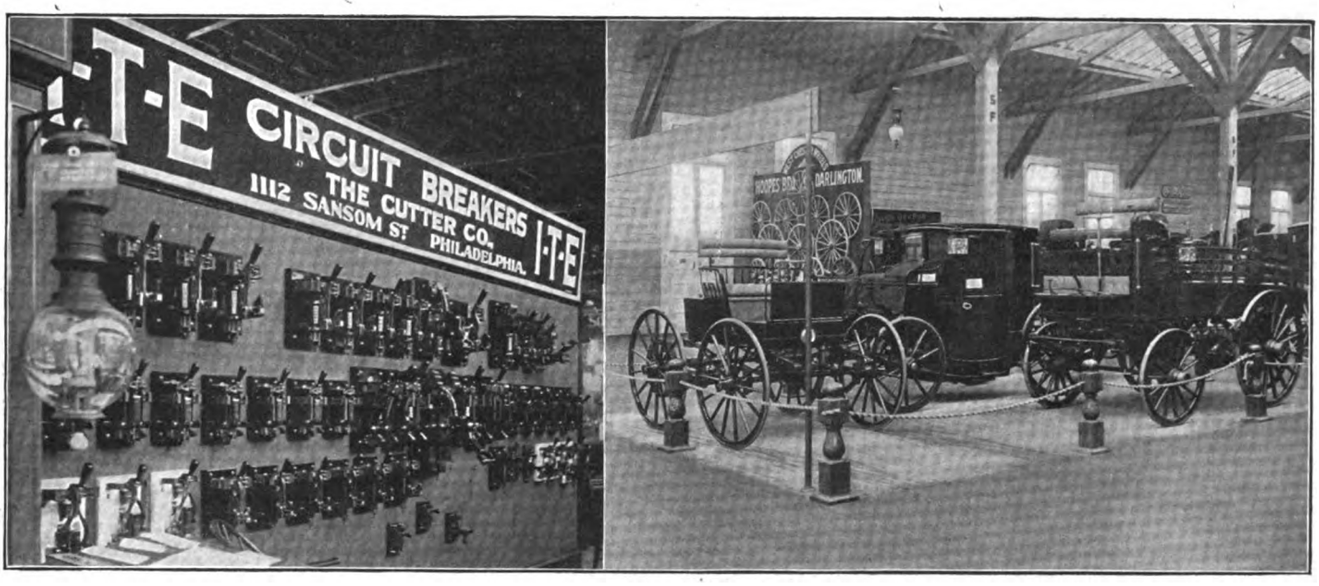
The magnitude of the exposition is far from realized by those who have not visited it. An idea of its scope can be given by figures as to the financial outlay involved. The United States Congress appropriated $300,000 for the buildings, part of which are permanent in character and designed for the continued use of the Philadelphia Commercial Museum. The City of Philadelphia appropriated $200,000 for the use of the Museum and the State of Pennsylvania appropriated $50,000 for erecting and equipping the power station, which is also permanent, as well as $25,000 for other purposes. Over $100,000 was also raised by subscription. Congress also appropriated $50,000 to be expended for the purchase of samples of merchandise in foreign markets to be displayed at the exposition in order to give American manufacturers an idea of what they must meet in competition, this merchandise to become the property of the Commercial Museum.

The greater part of the exposition is housed in one mammoth main building nearly 1000x400 feet in size. This consists of three permanent pavilions of steel girder construction connected by arcades and halls of temporary construction. In addition to this building there is a separate structure for the vehicle and furniture exhibit and another for transportation exhibits.

The power plant of the exposition is in a special building adjacent to the tracks of the Pennsylvania Railroad. The boiler room contains three batteries of two boilers each, the boilers being rated at about 300 h. p. each. One battery was built by the Stirling Company, Chicago, one by the Heine Safety Boiler Company, St. Louis, and the third by Robert Wetherill & Co., Chester, Pa. The engine room contains one Armington & Sims engine,



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THE EXHIBITS OF THE CUTTER COMPANY AND OF THE GENERAL ELECTRIC AUTOMOBILE COMPANY.

driving two 125-volt 600-ampere G. E. dynamos. Another unit consists of an engine built by the Ames Iron Works, Oswego, New York, direct coupled to a Siemens & Halske 75-kw. generator of the outside armature type. Still a third engine is one built by the Harrisburg Foundry & Machine Works, which is designed for direct coupling, but at the time of the writer's visit was not fitted with a generator.

The steam piping from the boiler room to the engine room is neatly arranged, the pipes being fitted with Ludlow double-gate valves and covered throughout with H. W. Johns' asbestos coverings.

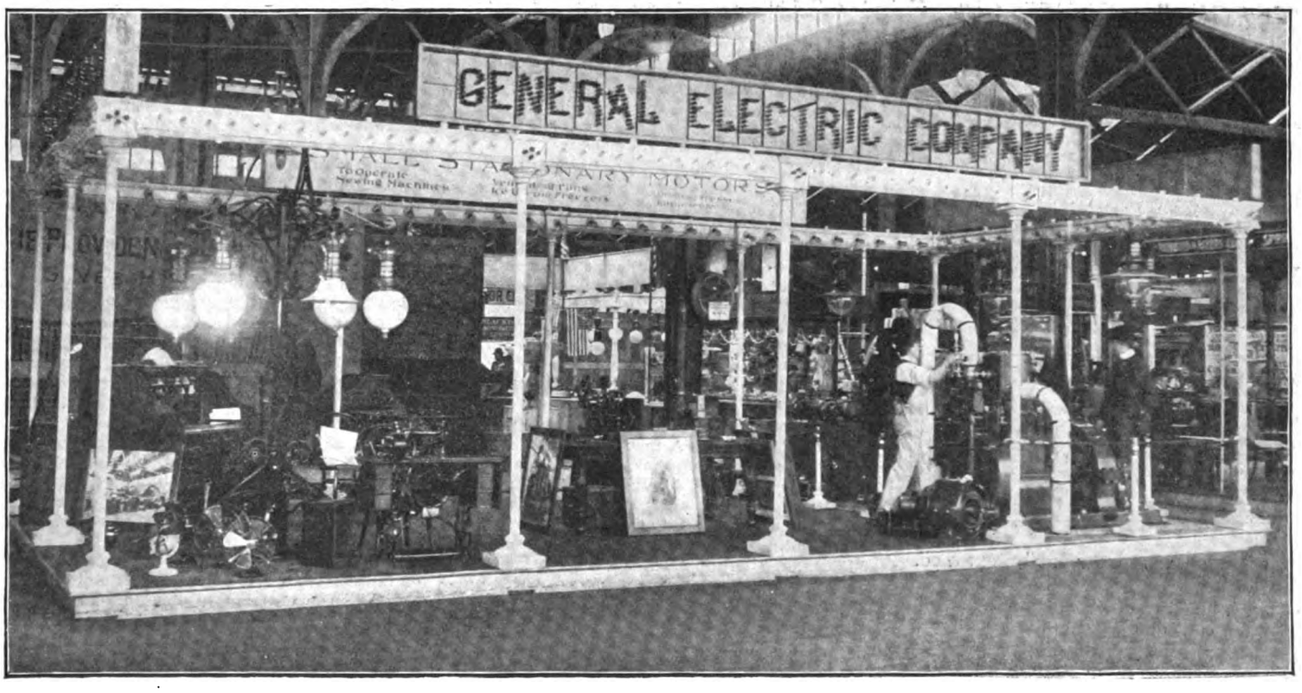
This power plant supplies two separate distributing systems throughout the main building, one of 110 volts and the other of 220 volts three-wire running incandescent and arc lights and motors. The switchboard of the plant was built by W. T. Pringle and, with the wiring, was installed by Keller, Pike & Co. The work was put in with great rapidity, the board, for example, being ordered on Sept. 4th and in service on Sept. 14th.

In addition the exposition gets alternating current at 5000 volts, two-phase 66 cycles from a station of the Pennsylvania Manufacturing, Light & Power Company, which power is transformed down in a pair of Wagner 250-kw. transformers to 2500 volts, at which pressure it is distributed throughout the grounds. The transformers are fitted with movable contacts by which the number of turns can be changed to alter the secondary pressure through a range of about 10 per cent. Quite a large number of Wagner single-phase motors are run throughout the exhibits from the alternating current mains.

The electric lighting is accomplished by means of some 5000 incandescent lights and some 450 arc lamps. Of these incandescents between 3000 and 3500 are used for illuminating the exterior of the main building, an idea of the effect obtained being given by the illustration on the previous page.

The lights grouped on the tops of the numerous flag poles are of 50 and 32 c. p., while those used to outline the windows are only of 10 c. p. All the incandescent lamps used by the exposition were made by the Fostoria Incandescent Lamp Company. The lighting of the grounds outside the building is largely accomplished by means of incandescent mantle burners of various types, worked with petroleum products.

The chief engineer of the exposition is Mr. John Birkinbine, President of the Franklin Institute, the electrical work being under the immediate charge of Mr. C. O. C. Billberg.



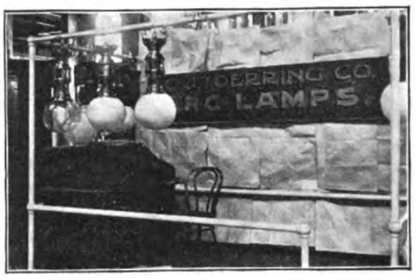

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## THE EXHIBITS.

Of the exhibits in electrical and the allied lines of steam and street railway engineering there are so many that but brief mention of each can be made in these columns.

The General Electric Company has under the direction of its foreign department perhaps the most comprehensive collection of electrical apparatus in the exposition. The machines shown are so far as possible in actual service, being driven in part by power derived from a 15-kw. General E ectric marine set mounted and running in the booth, and in part by alternating current from the a.c. mains of the exposition described above. The new constant current alternating arcs of what are known as the Hartford system are in service in this booth to the number of four, supplied by a 3-kw. transformer designed to give 6.6 amperes to the lamps when run from a 2200-volt primary circuit. The transformer case is fitted with windows, through which the construction of the interior and the operation of the parts on the vice for recording wattmeters and an electric driving equipment for sewing machines. This consists simply of a small a.c. or d.c. constant speed motor belted to the sewing machine over an idle pulley. This pulley and a brake are attached to a pedal so that the speed of the machine can be adjusted mechanically. The direct current motor for this purpose is shunt wound and is fitted with an armature resistance which is automatically cut out by a centrifugal device on the motor armature.

The exhibit which comes next in interest to the average electrical engineer is that of The Cutter Company, Philadelphia. The space occupied by this company contains one large board covered with more than 50 breakers of the different types and sizes made by this company for all purposes. The largest circuit breaker of the collection is one of the new laminated wedge type described in the July issue of the American Electrician and rated at from 2000 to 5000 amperes. The variously operated releasing devices designed to respond to overloads, underloads, over-voltage, under-voltage, relay, etc., are to be with many breakers it frequently becomes desirable to temporarily increase the operating point of a large number of breakers to carry a heavy load for a short time or while




THE ARC LAMPS OF THE C. J. TOERRING COMPANY.

throwing in new generators, or otherwise disturbing the load in such a way as, so to speak, to electrically jar the circuit breakers.




THE EXHIBITS OF THE WAGNER ELECTRIC AND MANUFACTURING COMPANY AND OF THE S. MORGAN SMITH COMPANY.

magnetic repulsion principle can be seen. Of motors the booth contains the new C.E. type for direct currents and two samples of the single-phase induction motor, one of which is equipped with the new condenser starting



THE APPARATUS SHOWN BY QUEEN & CO.

device, while the other must be started by hand, but runs up to speed in either direction. Among other apparatus are the two-rate meter, the prepayment or coin-in-the-slot de- found in many standard types in this exhibit besides many combinations which in the present state of the art may be styled by the term "freak," although, as the needs of electric plants become more varied these freak combinations may become standard types. The underload breaker, for example, is made in a polarized form in the laminated wedge type, the polarization being obtained by adding a shunt coil around the one magnetic circuit. This modification makes the breaker operative only to reverse currents, the armature of the compound wound magnet only letting go when the series current reverses from its normal direction. Another interesting type is the double coil, triple-pole type for three-wire or polyphase systems, the two coils being respectively in the outer conductors of the three-wire system or two legs of a three-phase system, thereby protecting the lines against an overload on either side in the former case or an overload on any phase in the latter case. A new and ingenious departure in circuit-breaker construction is embodied in what is known as the internal-shunt type. This consists of a breaker with the ordinary latch and plunger, the series coil surrounding the latter being fitted over a high-wound shunt coil. This shunt coil can be connected up at times with a weak current in such a direction as to oppose the magnetism set up by the series coil so as to increase the load which the breaker will carry without opening. On street railway boards Instruments of this internal shunt type with their auxiliary coils all connected to one switch can at an instant's notice have their operating limit increased in this manner. The shunt coils can also be used in connection with a push button and a strong reversed current to throw the breaker on the relay principle.

The arc lamp exhibits are four in number. The Jandus Electric Company, Cleveland, Ohio, has in the exposition a sample of each of its various types of lamps. The C. J. Toerring Company, Philadelphia, has on view a number of its lamps which were recently described in these columns. The Helios Electric Company of Philadelphia makes a showing of its arc lamps and switchboard work, and the International Arc Lamp Company of New York also occupies a booth.

Of wire and cable manufacturers there are two representatives. The Standard Underground Cable Company of Pittsburg has a number of show cases containing samples of its products for various branches of electrical work. The John A. Roebling's Sons Company makes practically the same exhibit as that made at the Electrical Show in May of this year.

Of electric elevators the only exhibit is that of Morse, Williams & Co., Philadelphia, who installed the three main elevators in the exposition building and in addition occupy a booth where they show various samples of their apparatus.

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Of instruments and electrophysical apparatus Messrs. Queen & Company, Philadelphia, make a showing of the Queen-Wirt measuring instruments and portable testing sets. An interesting instrument in the Queen-Wirt portable projection galvanometer for lantern use. This consists of an instrument with a needle projecting out horizontally over a lantern slide on which a vertical scale is mounted. By inserting the slide in the stereopticon the exact position of the needle on the scale can be projected on the screen.

Of electric automobiles the General Electric Automobile Company, Philadelphia, makes the only exhibit, but one so complete that it partially makes up for the lack of others. The exhibit is contained in the building devoted to vehicles, its only competition in the automobile line being some carriages fitted with steam motors. An idea of the appearance of the exhibit is given in the illustration on page 543. The vehicles shown are one delivery wagon, one brougham and one runabout.

Of gas engines the most extensive exhibit is that of The Otto Gas Engine Works, Philadelphia. The exhibit contains as its main features one 60-h.p. engine driving part of the shafting of the main building and another 60-h.p. belted to a dynamo. These engines have some recently designed features, one of which is a new self-starting arrangement which consists of a hand pump for pumping air and gas into a chamber connected with the cylinder head, where it may be exploded when the piston is at the proper point of the cycle, giving the engine an initial impulse sufficient to turn it over and allow it to bring itself up to speed. In addition to these engines there are others driving respectively a Wagner 200-ampere dynamo and a Diehl 22½-kw. generator, besides hoisting and pumping engines.

Of general power transmitting machinery The Geo. V. Cresson Company, Philadelphia, makes an extensive exhibit containing one piece of apparatus of particular electrical interest. This consists of a magnetic separator designed for the concentration of magnetic ores. In addition there are Pelton water motors, samples of shafting, pulleys, etc.

Of valves and general steam fittings there are many. The Eynon-Evans Manufacturing Company, Philadelphia, has a booth filled with Eynon-Korting compound injectors, steam traps, blowers and blast nozzles, compressors and exhausters and steam jets for removing gases or liquids all on the injector or ejector principle. The Ludlow Valve Manufacturing Company has an exhibit space filled with substantial looking supplies turned out from its works at Troy, New York. Among them are indicating valves, hydraulic gates, float valves, relief foot valves, etc. The Ashton Valve Company, Boston, Mass. makes the exhibit of its "pop" safety valves, water relief valves, gages, etc., which is familiar to the attendants at previous expositions. The William S. Haines Company, Philadelphia, shows its pressure regulators, thermometers, thermo-regulators, safety, valves, steam traps, etc., generally known by the name of Heinz and dependent for their operation upon the expansion and contraction of a flattened tube.

Of pipe coverings for heat insulating purposes the only exhibit outside of the material used on the piping system of the plant is made by Keasbey & Mattison, Ambler, Pa. The exhibit consists of magnesia coverings in straight tubes and various special forms such as T's, Y's and elbows, asbestos wick packing and Ambler asbestos air cell covering.

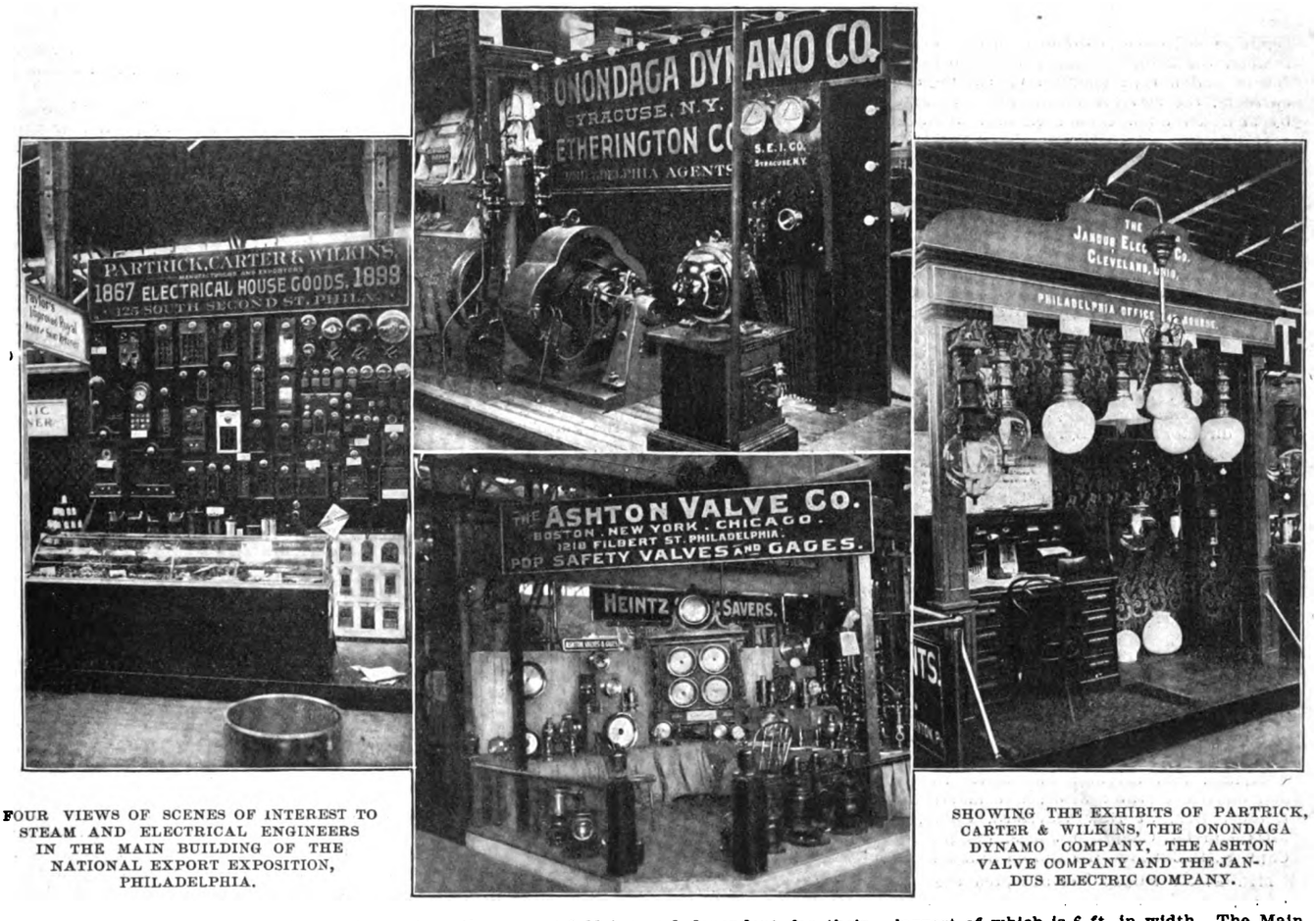
Of turbines the only exhibit is that of the S. Morgan Smith Company, York, Pa. This company's booth contains samples of McCormick and New Success turbine wheels in both the vertical and horizontal types, the latter being in a closed flume. The vertical shaft wheels illustrate both the cylinder gate and the adjustable guide-chute methods of governing.

Of general electrical supplies and house goods an extensive exhibit is that of Partrick, Carter & Wilkins of Philadelphia. The booth of this company, which is shown in one of the accompanying illustrations, contains a complete line of annunciators, bells, etc., as well as more special apparatus, such as tank alarms, burglar alarms, with automatic clock cut-offs, servant's calls, etc.

Of motors, transformers, switchboards, ventilating sets, etc., the Wagner Electric Manufacturing Company, St. Louis, Mo., makes an extensive exhibit, a view of which appears on the preceding page. Besides this, Wagner single-phase motors are scattered around the buildings and one Wagner motor generator set consisting of a single-phase motor coupled to a d. c. dynamo is used in the vehicle building.

Among the manufacturers of belts three are prominently represented at the exposition. J. E. Rhoads & Sons of Philadelphia have in addition to their belting in use in the power plant a booth containing many samples, the largest of which is 6 ft. in width. The Main Belting Company, Philadelphia, shows a full line of Leviathan belts from the 90 in. 8-ply down. Chas. A. Schieren & Co., New York City, also make an interesting showing in addition to having considerable belting in use around the hall.

Of boilers the exhibits—besides those mentioned above as in use in the power plant—are two in number. One of these is the newly reorganized National Water Tube Boiler Company of New Brunswick, N. J., showing a model of its boiler. The other exhibit is made by the Harrison Safety Boiler Works, Germantown, Pa. This exhibit contains Cochrane separators and receiver separators, a large heater and purifier and a section of the Harrison Safety boiler.




FOUR VIEWS OF SCENES OF INTEREST TO STEAM AND ELECTRICAL ENGINEERS IN THE MAIN BUILDING OF THE NATIONAL EXPORT EXPOSITION, PHILADELPHIA.

SHOWING THE EXHIBITS OF PARTRICK, CARTER & WILKINS, THE ONONDAGA DYNAMO COMPANY, THE ASHTON VALVE COMPANY AND THE JANDUS ELECTRIC COMPANY.

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## LEGAL NOTES.

THE STANLEY INSTRUMENT COMPANY vs. THE GENERAL ELECTRIC Company.—The Stanley Instrument Company of Great Barrington, Mass., has brought suit against the General Electric Company for infringement of a patent on alternating-current wattmeters. This patent is No. 423,210, issued March 11, 1890, to O. T. Blathy, the Stanley Company claiming that the patent is fundamental and covers broadly induction wattmeters. Both of the two claims of the patent, however, specify independent and non-intersecting magnetic circuits excited respectively by the shunt and series coils, an arrangement that is not used in many meters.

POLYPHASE MOTOR CASE.—An opinion was handed down Sept. 27th, 1899, by Judge McPherson of the Circuit Court of the Eastern District of Pennsylvania, in the case between the Tesla Electric Company (absorbed by the Westinghouse Electric & Manufacturing Company), complainant, and Scott & Janney, et al., defendants, alleging infringement of patents No. 511,915 and 555,190, granted to Nikola Tesla. These patents claim "split-phase" devices for alternating-current motors, the Scott & Janney motor being of the induction type supplied by single-phase currents, the starting torque being obtained by short-circuited coils each surrounding a part of each pole. The opinion upheld the complainant.

## PERSONALS.

MR. ENOS M. BARTON, president of the Western Electric Company, was married in London, England, on Friday, October 6th, to Miss Mary Rust, daughter of Major Henry A. Rust, Chancellor of the University of Chicago.

MR. IRA A. McCORMACK, formerly superintendent of the Brooklyn Rapid Transit Company, has resigned from this position to become the vice-president and managing director of the Syracuse Rapid Transit Company.

MR. H. C. FARNSWORTH, who for a number of years travelled throughout the New England States, selling electrical machinery, is now representing the Sprague Electric Company in that territory, having offices in the Exchange Building, Boston.

Mr. R. McALLISTER LLOYD has been elected president of the Electric Vehicle Company in place of Mr. Isaac L. Rice, who has retired from this position as well as the presidency of the Electric Storage Battery Company to attend to other pressing business.

LIEUT. FRANK J. SPRAGUE, the well-known president of the Sprague Electric Company, and inventor in electric railway and electric elevator fields, was married on October 11th, at New Hartford, Conn., to Miss Harriet Chapman Jones, daughter of Capt. H. R. Jones of the United States Army.

MR. D. M. BLISS has accepted the offer of a position with the New England Motor Company, Lowell, Mass., as Superintendent and Electrical Engineer of the company's new factory. Mr. Bliss spent several years with the Holtzer-Cabot Company of Brookline, Mass., and more recently has been connected with the B. F. Sturtevant Company, Boston, Mass.

MR. W. J. JOHNSTON, formerly publisher of the "Electrical World," who started from this country in August for a trip around the world, has been reported in Japanese papers as being in Japan during the latter part of September. From Japan Mr. Johnston goes to the Philippines and then completes a circle of the globe by visits to Java, India, Egypt, Turkey, Greece, Spain, etc. After attending the Paris Exposition Mr. Johnston expects to return to New York during June or July, 1900.

## TRADE PUBLICATIONS.

THE INTERNATIONAL CORRESPONDENCE SCHOOLS, Scranton, Pa., have published their pamphlet entitled "A Book of Success" describing the work and equipment of the schools, in a special cover designed as a souvenir of the National Export Exposition. The schools are also circulating a leaflet giving the commissions which will be allowed to students in case they aid in securing the enrollment of others.

THE STEWART ELECTRICAL COMPANY, Cincinnati, O., has adopted the bulletin method of advising its patrons and possible patrons of its ability to meet their wants. Recent bulletins call attention to the Stewart Company's willingness to supply the needs of users of electrical machinery from the want of a new commutator brush to the purchase, sale or exchange of a complete plant.

THE SPRAGUE ELECTRIC COMPANY, New York City, has published a handsomely illustrated catalogue of the Lundell generators. In addition to the well-known single-field coil type the company is now building a larger machine of what is known as the split-pole type embodying a new principle designed by Mr. Robert Lundell for forcing the increased field strength with increased load into the proper horn of the pole to give correct commutation.

THE LYNN INCANDESCENT LAMP COMPANY, Lynn, Mass., shows the nature of its work to its correspondents by three full-sized illustrations of lamps printed on the back of its letter heads. One of these shows a 55-volt lamp after renewal by the Lynn Company with a filament of the plain horse-shoe type. Another shows a 110-volt lamp after renewal with the type of filament which the company uses for this purpose, viz., the coiled filament. The third shows the lamp which the Lynn company makes for 100 to 125 volt circuits containing a filament of the oval-anchored type, the filament being fastened to the glass stem instead of to a metal support.

THE JOSEPH DIXON CRUCIBLE COMPANY, Jersey City, N. J., is trying to impress steam engineers about the country with the value of Dixon Ticonderoga flake granite for the lubrication of cylinders and valves. With the increasing use at the present day of high steam pressures, and especially of superheated steam, cylinder lubrication with oil is far from satisfactory. A mineral oil lacks body and animal oils char with the high temperatures of modern steam practice and form a gummy mass on cylinders and pistons. A finely ground flake graphite gives a body which with mineral oils is not affected by any degree of heat, and fills up the microscopic inequalities of the bearing surfaces, making them almost ideal in smoothness.

THE MURPHY IRON WORKS, Detroit, Mich., is circulating a leaflet signed by Mr. O. D. Cotton, criticising a pamphlet previously circulated by the Hawley Down Draft Furnace Company containing a report of the comparative tests of the Hawley down draft furnace and the Murphy automatic stoker carried out at the Oliver rod mill of the American Steel & Wire Company in Pittsburgh. Boiler tests involve so many factors that it is possible in a report of them to misrepresent the conditions and thus falsify the conclusions, and Mr. Cotton's contention in the criticism above referred to is that the engineers making out this report were influenced in favor of the Hawley Company and that the report was on this account an unfair one to the Murphy stoker.

THE SHERWOOD MANUFACTURING COMPANY, Buffalo, N. Y., lists in its catalogue of engine and boiler supplies a large number of improved appliances for engine lubrication and boiler cleaning. Among the former are automatic cylinder lubricators, oil pumps and oil cups of various types, and among the latter are flue scrapers, flue blowers and the "Niagara" tube cleaner. This instrument is intended for removing the scale from the interior of water-tube boilers of the straight tube type and consists of a small turbine mounted on ball bearings and attached to rotating cutters. By inserting this into the water-tube and driving a jet of steam or a powerful stream of water at high pressure through it the turbine rotates the cutters at a high speed and disintegrates the scale, which is washed away with the jet. The "Niagara" tube cleaner is claimed to be the original machine of this type, and is the specialty of the Sherwood Manufacturing Company. About 1000 are already in use in this country. The confidence of the makers in its satisfactory action is so complete that they send it on approval. The Sherwood Manufacturing Company has depots in New York, Boston, New Orleans, St. Louis, Chicago and San Francisco.

THE CLING-SURFACE MANUFACTURING COMPANY, Buffalo, N. Y., in a reprint of Prof. R. C. Carpenter's report of tests of Cling-Surface noted in the American Electrician of May, 1899, gives further data of interest abstracted from a letter from Prof. Carpenter written Oct. 5th, 1899, and reading as follows:

"Later tests of the use of Cling-Surface on belting substantiate in every particular the statements made in my report of April 17th. They also indicate higher efficiency of transmission and less loss of power in the case of belts treated with Cling-Surface than in the case of belts not so treated, when working under the conditions prevailing at the time of the earlier test. This is due to the fact that the slipping of a belt causes considerable loss of power, the power so lost passing off in heat. The use of Cling-Surface reduces the slipping and consequently reduces the loss of power occasioned by the use of belts that slip.

"During the past six months I have had occasion to observe the practical use of Cling-Surface in a number of instances. In all such cases Cling-Surface has improved the belts by softening them, and as far as I can determine in the limited time (seven months) tends to preserve the leather of which they are constructed."

## BUSINESS NEWS.

THE CREFELD ELECTRICAL WORKS, Saylesville, R. I., have been bought by the American Electrical Works, and the plant has been removed to a substantial new three-story brick building 130 ft. by 60 ft., adjoining the American Electrical Works' factories at Phillipsdale, R. I.

E. W. BLISS & COMPANY, Brooklyn, announce that they have recently moved their Western Office to 22-24-26 South Canal St., Chicago, Ill., where they will carry a full line of their standard machines and where Mr. W. D. Smith, who is in charge, will be pleased to communicate with any one in that section who is interested.

THE BALL ENGINE COMPANY, Erie, Pa., has sold to the Machinery & Electrical Department of the United States Commission to the Paris Exposition a 350-h. p. tandem compound engine, arranged for direct connection to a Bullock generator, to be used as a working exhibit in the machinery annex at Vincennes.

TROTTER'S MONA MANUFACTURING COMPANY, LIMITED, manufacturers of Trotter's commutator compound, has removed its offices from 65 W. Broadway, to more commodious quarters at 320 Broadway, New York, where Prof. Trotter will be pleased to receive his friends, and all interested in the commutator compound.

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THE NATIONAL CONDUIT & CABLE COMPANY suffered on October 13th from a fire which did about $100,000 worth of damage at the company's works in Hastings, N. Y.

ROSSITER, MACGOVERN & CO., New York City, have purchased the entire factory, tools, machinery and equipment of the old Excelsior Electric Company in Brooklyn, N. Y. This will increase greatly the facilities and resources of Rossiter, MacGovern & Co. in their work of repairing and renewing second-hand electrical machinery.

THE AULTMAN-TAYLOR COMPANY, Mansfield, Ohio, has closed a contract with the New York Gas, Electric Light, Heat & Power Company, the Whitney syndicate controlling the Edison and other lighting companies of Manhattan Island, for 56 boilers, aggregating 3900 h.p., to be installed in the new Riverside generating station in New York City.

THE NEW YORK TRADE SCHOOL began on October 27th a series of 12 lectures for journeymen electrical workers, to be carried through the winter. These lectures are conducted by Mr. Arthur Hamerschlag, and consist of simple talks concerning the materials and the proper method of doing the work that members of the audience customarily engage in.

THE TUCKER MANUFACTURING COMPANY, York, Pa., reports that its business has increased to such an extent as to compel the placing of new machinery throughout the entire factory. The company is now prepared, owing to these increased facilities, to fill orders promptly. The company is arranging to increase its capital stock from $5,000 to $25,000.

THE WESTINGHOUSE MACHINE COMPANY proposes to build a steel foundry and steel forging mill at East Pittsburgh that will cost $1,250,000, and have a capacity of 80 tons of steel castings and forgings per day. The new plant will be erected immediately to the west of the present shops, and will consist of two steel frame buildings about 400 ft. long and 150 ft. wide.

MR. CHAS. J. BOGUE, New York City, has recently sold two focusing electric arc lamps designed for running in series with each other on direct current for use in the photo-lithographic work of the Department of the Interior of the United States Government. The United States Engineer's Office has also bought from the same maker one 14-in. pilot-house projector.

THE NEW ERA IRON WORKS COMPANY, Dayton, O., manufacturer of the "New Era" gas and gasoline engines, has recently purchased a new plant, which it is now remodeling and equipping with all the latest improved machinery. The demand for the "New Era" engines has been such as to warrant this action, which by January first will double the capacity of the company's works.

MANUFACTURERS of arc and incandescent lamps, porcelain fittings and general wiring materials for out and indoor work are invited to send catalogues, price lists, etc., to Mr. E. R. Dodge, Mechanical Electrician at the Civil Engineer's Office of the United States Navy Yard, Portsmouth, N. H. This yard will have a considerable amount of construction work in the near future and bids on material will be asked.

GATES & RANDOLPH, Chicago, report a constantly increasing business and that they have sold thirty odd complete electric plants during one month. Realizing the coming extensive use of electric motor carriages, they have also taken the agency of the Indiana Bicycle Company of Indianapolis, manufacturers of the "Waverly" automobile in all styles. A number of these carriages were on exhibition at the street railway convention.

THE UNION BOILER TUBE CLEANER COMPANY, Pittsburg, Pa., has recently finished what is claimed to be the largest contract ever awarded for cleaning boilers, being for twenty-two water tube boilers, containing an aggregate of ten miles of 4-in. tubes. The company has just shipped eight machines to England and Scotland. The first machine exported was shipped just one year previously. One of those recently shipped was a repeat of the first order.

THE CUTLER-HAMMER MANUFACTURING COMPANY, formerly of Chicago, on account of the great increase of its business, has been compelled to seek new quarters. The new location is in Milwaukee, Wis., where the company will occupy a three-story brick building specially erected for its use. The building has been equipped with the latest and most approved machinery and will enable the company to turn out a much larger product than it could handle at the old location. The Cutler-Hammer Company has also an office at 136 Liberty Street, New York City.

THE NEW ENGLAND MOTOR COMPANY, Lowell, Mass., reports a steadily increasing demand for its products. That its new four and six-pole slow-speed motors and generators meet the needs of motor users is evidenced by the number of orders obtained for them. The factory has been working overtime for the past six weeks, turning out the bipolar type in medium and smaller sizes. The company has recently equipped a new building with the most modern tools so that it is now in a position to furnish machines from ½ to 150-kw. capacity, and can make prompt shipments of the sizes most in demand.

THE PIERCE-CROUCH ENGINE COMPANY, manufacturers of gas and gasolene engines, with works located at New Brighton, Pa., reports having sold during the month of September for use in electric lighting plants in the Pittsburg district alone five 35-h.p. and one 25-h.p. engines. Besides this there were sold many engines for other purposes, one sale being the last two of eight engines furnished one company. When these two are installed the entire plant of this company will be run by gas engines. The Pierce-Crouch Engine Company is adding new machinery to its plant, which will soon enable its output to be doubled.

THE BULLOCK ELECTRIC MANUFACTURING COMPANY, Cincinnati, O., reports sales for the month of September involving sixty-one machines ranging in size from three to one hundred and fifty kilowatts. Among the more important were fifteen engine-type generators for United States army transports and ten 50-h.p. motors to operate at 200 r.p.m., for Messrs. Dick, Kerr & Co., of London, England. A new bulletin No. .0435, just issued by the company, describes type "N" motors. This is the first bulletin of the standard 6 in. x 9 in. size which has been issued. Those interested in electrical literature will appreciate this reduction in size, as it is more readily filed than the larger pamphlets.

THE WOODS MOTOR VEHICLE COMPANY is the name of the new corporation which has taken over the building of electric automobiles under the designs of Mr. C. E. Woods, as formerly carried on by the Fischer Equipment Company of Chicago. The success of automobiles in general and the Woods vehicle in particular is such that the company has been incorporated with a capital stock of $10,000,000, and with a directorate containing such well-known men in the financial world as Messrs. John W. Mackay, August Belmont, Dr. W. Seward Webb, Sir William Van Horne, etc. The company starts out with complete designs for thirty different styles of vehicles, embracing a general line from the light buggy to victorias, broughams and cabs.

THE MANHATTAN GENERAL CONSTRUCTION COMPANY, Newark, N. J., manufacturer of the "Manhattan" arc lamp, is meeting with marked success in the introduction of the Manhattan series alternating current enclosed arc system described in the last issue of this paper. Among some of the contracts which have been closed the company mentions contracts for 850 lamps and 9 regulators for the San Gabriel Electric Company, Los Angeles, Cal.; 1 regulator and 25 lamps for the People's Gas & Electric Co., Peoria, Ill.; 1 regulator and 35 lamps for the Electric Light Co. of Hot Springs, Ark.; 3 regulators and 117 lamps for the Middlesex & Monmouth Electric Co. of Mattewan, South Amboy and Keyport, N. J. The company is operating its factory at Newark night and day in an endeavor to catch up with the orders at present on its books.

THE WARREN MANUFACTURING COMPANY, Chicago, Ill., offers belt users a simple solution of the problem of slipping belts. Every engineer realizes that a highly polished iron pully is about as unsuitable a device for transmitting power to belts as could be arranged since it requires a very high belt tension to obtain the necessary resistance to slippage. This belt tension increases journal friction, wears out the belt and is generally troublesome. Leather and canvas coverings are often used, but they are troublesome through the necessity of frequent renewals. The Warren Manufacturing Company offers a liquid pulley cover which can be applied with a brush, dries in a couple of hours, and is then ready for use. This pulley cover is not injured by oil or grease. It is designed to cure the troubles incident upon too short a distance between belt centers and to allow dynamos and motors to be placed nearer together in cases where it is desirable but otherwise impossible to do so.

THE MURPHY IRON WORKS, Detroit, Mich., has obtained a second order for Murphy automatic smokeless furnaces at The Standard Plate Glass Company's works at Butler, Pa., the first order having been installed last spring under guarantee of superior results in every respect over the front feed stokers then in use. The American District Steam Company, Lockport, N. Y., is also installing Murphy automatic smokeless furnaces in place of the mechanical stokers of another make installed there last year. Murphy automatic smokeless furnaces are also to be placed in connection with the eight 400-h. p. B. & W. boilers in the new central power plant of Swift & Company at the Union Stock Yards, Chicago. The company also has been given the contract for equipping the fourteen 250-h. p. boilers for the Columbia Chemical Company's large new works at Barberton, O. The Wagner Sleeping Car Company also has contracted with the Murphy Iron Works for Murphy automatic smokeless furnaces for the boilers in its works at Buffalo, N. Y.

THE MANHATTAN BUILDING, St. Paul, Minn., has been sold to Mr. Charles Lockhart, one of the Standard Oil magnates of Pittsburg, Pa. This sale includes the Manhattan Light, Heat & Power Company, which was operated to supply the building and neighboring structures as a sort of block central station. The price paid for the building and the lighting and heating plant was $500,000. The new company has contracted for additional machinery for the heating and lighting department, having purchased a 250-h.p. water tube boiler from the Stirling Company, Chicago, and an engine from the American Engine Company, Bound Brook, N. J., which is direct connected to a 75-kw. generator made by the Triumph Electric Co., Cincinnati, O. The company is also installing a large marble switchboard, having the very latest appliances, and contemplates extensive improvements and extensions in its underground system. Mr. A. Wilford Zahm, formerly Superintendent for the Manhattan Light, Heat and Power Company, has been retained as Manager for both the Manhattan Building and the Manhattan Light, Heat & Power Company.

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## STREET RAILWAY CONVENTION NOTES.

A. L. IDE & SONS, Springfield, Ill., were represented by their genial Chicago agent, Enos Bookwalter.

OF THE ARNOLD ELECTRIC POWER STATION COMPANY, Chicago, Mr. B. J. Arnold and Mr. George A. Damon were at the convention.

MR. FRED H. ALDEN, President of the Illinois Insulated Wire Company, Sycamore, Ill., had his usual pleasant word for all his acquaintances.

A. C. BECKEN, Chicago, exhibited a case of Paillard non-magnetic watches which are claimed to be absolutely uninfluenced by magnetic or electric action.

THE BALL ENGINE COMPANY, Erie, Pa., while not making an exhibit, had its interests carefully attended to by its western representative, Mr. W. A. Kreider.

THE HEINE SAFETY BOILER COMPANY, St. Louis, was present in the person of its Chicago representative, James H. Harris, who has represented this firm in Chicago for nearly twelve years.

Mr. E. J. BAGNALL of the Adams-Bagnall Company, Cleveland, O., managed to spend a few hours at the convention, where he renewed many old acquaintances. Mr. Pomeroy, western representative of this company, was also in evidence.

THE WARREN MANUFACTURING COMPANY, 65 S. Canal St., Chicago, was represented by Mr. E. H. Warren, Pres., and Mr. Alfred Warren. They showed a line of samples of their liquid pulley covering and a vast number of testimonial letters.

THE WESTERN ELECTRICAL SUPPLY COMPANY, St. Louis, which has rapidly built up a large business in the Southwest in the handling of street railway supplies, was represented by the manager of its street railway department, Mr. Chas. Scudder, Jr.

THE CLING-SURFACE MANUFACTURING COMPANY, Buffalo, N. Y.—Mr. F. C. Willis did the honors of the convention for this company. It is questionable whether any company distributed larger quantities of printed matter than did this company during the sessions of the convention.

THE GREEN ENGINEERING COMPANY, Chicago, was represented by P. Albert Poppenhusen. This company has recently secured several of the largest orders ever placed for traveling grates. The company represents the Edgemoor Iron Co., Goubert Mfg. Co., Broomell, Schmidt & Co.

THE MILLER-KNOBLOCK COMPANY, South Bend, Ind., was represented by its manager, Mr. A. W. Morrell. The exhibit showed a full line of assembled commutators for all standard street railway motors, the workmanship on which attracted general attention. Constantly increasing business has made it necessary for the company to double its capacity.

THE EUREKA ELECTRIC TELEPHONE MFG. CO. of Chicago made one of the interesting exhibits, because it was nearly the only one in its line. This company manufactures a line of special telephones adapted for street railway work and found many interested inquirers among street railway delegates. Both Mr. Kusel and Mr. Stein were in attendance.

THE SPEER CARBON COMPANY, St. Marys, Pa., had able representation in the person of Mr. Jonn S. Speer, General Manager of the company, assisted by Mr. Andrew Call, Sec. and Treas. The product of the company was kept prominently to the front and the representatives were most generous indeed with souvenirs, giving out a handsome coin and bill case, pocketbook and cigar case.

THE SWARTS METAL REFINING COMPANY, Chicago, has a name well known to street railway people throughout the continent, through its business in the handling of worn-out trolley wire, scrap windings, brass castings, etc., etc. The company also furnishes a superior metal for motor bearings, which is coming into general use on many roads. The company was represented by its president, S. Swarts.

THE CENTRAL UNION BRASS COMPANY, St. Louis, was represented by its manager, T. C. White. This company is bringing out an extensive line of overhead material and making a special effort to meet the most exacting street railway demands. Mr. White reports that the factory is very busy and that the new material is meeting with much favor from street railway companies.

THE WESTERN ELECTRIC CO.—The exhibit of this company was made at its shops on the West Side, but a handsome souvenir was given out at the convention by the representatives present—a handsome match-box in white enamel and silver, showing the W. E. fan on one side and a "Petite" arc lamp on the other. Mr. A. L. Tucker visited the convention, while Mr. J. C. Cannon, Mr. Thos. Grier, Mr. Philip de F. Rust and Mr. Frank Swan were constant in their attendance.

THE CENTRAL ELECTRIC COMPANY, Chicago, has a very handsome booth decorated in yellow and black and with a number of steel trolley poles spanning the doorway. There was exhibited a display board made up of overhead material, car fixtures, etc., elegantly polished. These were mostly of the well known Wood type, manufactured by the Central Union Brass Company. A brass cannon, a yoke of brass oxen, and a brass street car attracted no small attention. The company's souvenir was a neat brass paper cutter.

THE STAR BRASS WORKS, Kalamazoo, Mich., had a neat booth in charge of Walter C. McKinlock. This company's trolley wheels, which have been on the market not quite two years, are running on thousands of cars. Some of their points of superiority were as follows: It will run in sleet longer than any other; is self-oiling and therefore saves bushings; will run smoother and last longer; is a better conductor and is not complicated; will not injure the overhead equipment and is made in the standard sizes, 4 inch and 6 inch, and will fit any standard harp.

K. McLENNAN & COMPANY, Chicago, sole manufacturers of Gale's commutator compound, were represented at their exhibit by Mr. W. J. Isaacs, the manager of the company. One of the features of their exhibit was a large bulletin board on which were attached several hundred extracts from testimonials, and at the side of the board two original testimonials were displayed. Judging from the number of samples which they gave out at their booth their compound is valued by the users of dynamos and motors. A neat souvenir was distributed in the shape of a "Mauser" cartridge knife.

THE LESCHEN, MACOMBER, WHYTE COMPANY, Chicago, was represented by F. B. Macomber, George S. Whyte and E. E. Robirds. The exhibit consisted of galvanized steel strand, galvanized curtain cord, galvanized telephone wire, rubber insulated wires and cables, weatherproof feeder wire, magnet wire, "Century" tape, "Beacon" bearing metal, overhead line material, and the "Standard" headlight. A neat paper cutter was distributed as a souvenir. While the principal business of the Leschen, Macomber, Whyte Co. is wire rope, its trade in the street railway field is rapidly increasing and is now reaching large proportions.

THE SIEGRIST LUBRICATOR COMPANY, St. Louis, had its booth enlivened by one of the best "coon" orchestras in town, whose good music constantly attracted and entertained a crowd. The company's booth was a handsome one, decorated in purple. There were exhibited automatic oil cups and automatic sight feed lubricators; a double automatic lubricator, having the advantage of two passages for the feeding oil, which removes in a large measure the danger of stoppage on account of an obstruction in the oil passages; also the company's standard automatic oiling table. The company's man-


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ager, J. N. Edelin, was present with a constant supply of good cheer for his friends.

EUGENE MUNSELL & CO. AND THE MICA INSULATOR COMPANY, Chicago, made a combined exhibit at the street railway convention, occupying a space of 200 square feet near the entrance. This exhibit consisted of mica in its natural state and in its various forms for electrical insulation, also stamped mica segments and washers, both India and Amber. Very large specimens of mica were shown, of interest to all electrical engineers and street railway managers. The exhibit of the mica insulator Co. consisted largely of "Micanite" rings, segments, tubes, troughs, cloth, paper, etc., etc. The exhibit was in charge of Mr. Charles E. Coleman, who has charge of the western business of the two companies.

THE CREAGHEAD ENGINEERING COMPANY, Cincinnati, made its usual large exhibit of flexible brackets, overhead line material, iron and wood pole fittings, rail bonds, etc. One particularly attractive feature of this exhibit was an extra heavy double bracket for center-pole construction which was recently supplied for the rebuilding of the overhead work on the New Orleans & Carrollton Railway, at New Orleans, La. A number of large photographs showing the company's material in use on roads in different parts of the world completed this particularly attractive exhibit, which was in charge of the superintendent, Mr. G. R. Scrugham. A steel pocket rule was given as a souvenir.

THE WESTERN ELECTRIC COMPANY was represented at the street railway convention by Messrs. J. C. Cannon, Philip Rust and F. L. Swan. They had headquarters in booth 30, where they entertained friends of the company and distributed printed matter and souvenirs to the visitors. Mr. A. L. Tucker of the Western Electric Company, was one of a committee on publicity for the convention. The souvenir distributed by the Western Electric Company at the convention was a matchbox having on one side an illustration of a Petite arc lamp, on the other an illustration of a 16-inch fan motor, and on both edges of the box—"Western Electric Company, Chicago—New York." The box is finished in silver and white celluloid.

THE GARTON-DANIELS ELECTRIC COMPANY, Keokuk, Iowa, was represented by J. V. E. Titus. The booth contained a panel mounted with Garton station-type arresters of different finishes and connected with the 500-volt circuit. By the aid of a static machine, the operation of the arresters was shown in a very satisfactory manner. They interrupt a short circuit so quickly that an ammeter shows little or no deflection. On a table was displayed a line of pole, station and car arresters, as well as samples of 500 and 800-ampere kicking coils, of which this company makes a specialty. This company also showed two samples of the automotoneer, an invention of Mr. George W. Knox, of the Chicago City Railway Company. This device prevents too rapid starting of electric cars and attracted lots of attention.

THE JOSEPH DIXON CRUCIBLE COMPANY, Jersey City, left its interests at the convention in charge of Messrs. Sam Mayer and Dudley Johnson, Chicago representatives, and Messrs. A. L. Harris, E. A. St. John and William Allen. The souvenirs of this company were large Uncle Sam pencils—also a trick pencil which, when once placed in the button hole, could not be detached without a deal of study, as well as plumbago medals made of the same graphite as that used in Dixon's pencils. The representatives of the company were kept busy booking orders for Dixon's graphited wood grease for gears of electric railway cars, of which they explained the merits in that it prevents noisy gears, keeps gears and bearings constantly lubricated, prevents all drippings from gear cases and lasts longer and is more economical than other lubricants.

THE GENERAL ELECTRIC COMPANY'S exhibit consisted largely of motors, containing, as it did, two G. E.-55 motors mounted on a truck complete as they will be used on the Northwestern Elevated in Chicago, two G. E.-1000 motors equipped with B-13 controller and electric brakes mounted on a St. Louis Car Company's truck, one G. E.-65 of 250-h. p. capacity built expressly for the Paris & Orleans Railway in France, and samples of the G. E.-52 and 57. There was also a line of standard switchboard panels, an air compressor, a large line of instruments, overhead material, motor repair material and apparatus for third-rail work. The delegates who attended the Convention in the exhibit of the General Electric Company were as follows: S. D. Greene, S. Trawick, Geo. Rosenthal, E. D. Mullin, T. P. Bailey, R. D. Beech, F. W. Willcox, F. E. Case, F. H. Strieby, A. H. Armstrong, W. F. Hayes, B. E. Sunny, F. Barbour, W. J. Ferris, E. D. Priest, J. J. Mahoney, F. M. Kimball, R. A. Swain, Geo. J. Cadwell, J. W. Johnson, W. B. Potter, F. N. Boyer, J. G. Barry, J. W. Buell, J. H Livsey, H. R. Bishop, Jr., Geo. Breed, R. E Moore, W. O. Carey, F. N. Boyer and Ward S. Arnold.

THE WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY made the most extensive exhibit in point of magnitude in the convention hall, its largest pieces of apparatus being a 500-kw. engine-type railway generator complete and a 200-kw. rotary converter with starting motor. Of railway motors assembled the company showed two pairs mounted in operating order on trucks, as well as three different styles assembled


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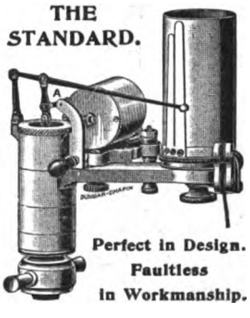
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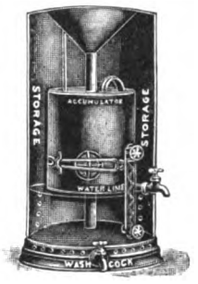
and several armatures complete and one under construction with commutator partially connected to show the internal arrangement. Among these motors were the new types No. 68 and No. 69, which are the latest built by the company, the particular improvement embodied in them being the increased current-carrying capacity of the field windings sufficient to equalize the heating between the armature and fields. A decided departure in the same motors is the use of poles bolted to the yoke instead of cast in as has been previous practice. The exhibit also contained one complete railway switchboard having three generator, one load and six feeder panels. The representatives of the Westinghouse Company attending the Convention were as follows: Messrs. Wm. Bauder, J. M. Duncan, C. S. Cook, F. McCoy, J. H. Reid, C. E. Skinner, N. W. Storer, F. S. Smith, W. M. Probasco, of Pittsburg; Messrs. W. S. Rugg, Irvin Dryer, C. W. Regester, Frederick Nelson; C. G. Burton, W. R. Pinkard, L. M. Harvey, T. A. Hall, T. P. Gaylord, Ivor Hennings, of Chicago; C. H. Bragg of Philadelphia, R. S. Brown of Boston, H. C. Marsh of Cincinnati, C. S. Powell of Cleveland, C. F. Medbury of Detroit, T. Julian McGill of Minneapolis, J. R. Gorden and E. Woodruf of Atlanta, Ga.; W. W. Grant of Ottawa, Ont., and A. Hatet of the Westinghouse Electric Company of France.

THE AMERICAN STEEL & WIRE COMPANY, Chicago, made a composite exhibit of all the different products of the company applicable in any way to street-railway or electric traction interests, and the diversity of these products was in many ways a surprise to those not familiar with the extent of the manufactures of this company. High above the booth swung a mammoth "Figure 8" rail bond, which was illuminated with more than a hundred incandescent bulbs and at night was one of the most brilliant features of the entire exhibit. The words "Crown Bonds" were brought out with numerous electric lights. Crown bonds, indeed, in innumerable shapes and sizes—straight and twisted to every known curve and angle formed the "piece de resistance" of the American Steel & Wire Company's exhibits. These bonds, however, were supplements on every side of the exhibit with devices calculated to interest every department of street-railway maintenance and construction; trolley wires, round and odd shaped, feeder wires and cables, steel-armored cables, lead-encased cables, submarine cables, magnet wires, every form of insulated wire, wire ropes, rheostat cables, car-truck springs, etc. These, again, were reinforced by a full representation of guy wires and span wires, both plain and twisted, also with huge pyramids of "high grade W. & M." double galvanized telephone and telegraph wires in "Extra BB," "BB," and steel grades. Another feature was an exhibit of woven-wire right-of-way fence which now is an important feature in the right-of-way program of the traction companies which are going "cross lots" among the inter-urban highways, finding it necessary in many cases to have the right-of-way securely as well as economically fenced in. A panel of the company's celebrated "American" style of fencing was shown erected on the posts with stretcher attached and in operation. The space allotted to the American Steel & Wire Company was completely filled with objects of interest to those concerned in the construction or operation of electric traction lines and was a center of interest during all the crowded periods of the exposition. Souvenirs in the form of solid leather memorandum and pocket books were judiciously distributed. Mr. E. J. Pietzcker was in charge of the exhibit for the electrical department, and Mr. George P. Rider was in charge of the fence exhibit.

AMONG OTHER VISITORS TO THE CONVENTION not exhibiting but interested observers from the central station or other electrical fields were: Mr. George S. Searing, western representative of the Hart & Hegeman Mfg. Co., Hartford, Conn.; Mr. W. G. Amos, Chicago agent of the Murphy Iron Works, Detroit, Mich.; Mr. J. A. Jones, of Kohler Bros., Chicago; Mr. J. B. Castle, of K. McLennan Co., who slipped in to the Convention the last two days and made his friends glad by his presence; Mr. Louis T. Grant, Gen. Mgr. Hawaii Automobile Co., Ltd., Honolulu, H. I.; W. E. Pimlott, representing the Martin J. Insull Co. and the General Incandescent Arc Light Co., Chicago; Mr. J. W. Hayden of Sherman & Hayden, Chicago; Mr. George Cutter, of Cutter & Co., 180 Lake St., Chicago; Mr. Edward W. Grier, western manager of the Bryant Electric Co., Hartford, Conn.; W. W. Lowe, president of the Electric Appliance Co., Chicago; Mr. Henry Shafer, Gen. Mgr., and Mr. P. J. Hertz, of the Stromberg-Carlson Telephone Mfg. Co.; and Mr. J. E. Smith, Supt. of Motive Power for Armour & Company.


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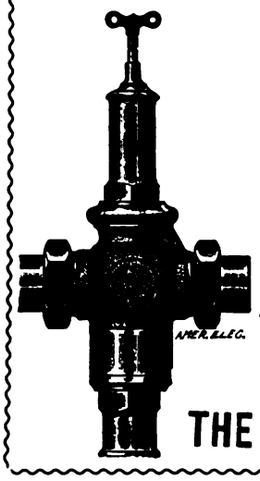
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# American Electrician.

Vol. XI. New York, December, 1899. No. 12.

# RECENT ADDITIONS IN THE POWER HOUSE OF THE NIAGARA FALLS HYDRAULIC POWER AND MANUFACTURING COMPANY.

**A Description of Many Special Machines for the Generation of Direct Currents for Electro-Chemical Purposes from Hydraulic Power.**

The two great electric power generating systems of Niagara Falls have been developed along radically different lines. In one all the dynamos are of the same size and type, and the electric power generated by them is then transformed to the various kinds and voltages of current required by different consumers. In the other—the recent developments of which it is the purpose of this article to describe—the dynamos are of various types and sizes, each designed to deliver its output directly in the kind of current used in the consuming devices, thus doing away with intermediate transformations and conversions. Each plan has its advantages and disadvantages. The cost of generation of the power is undoubtedly lower when it is all generated in one form, but when it has to be converted into another form, such as direct current, the cost of this final form may become greater than if it were directly generated in the dynamos. For this reason the loads at Niagara Falls have naturally been divided between one or the other power house according to this basis. All loads which could use the more cheaply generated power in its original form, viz., 25-cycle alternating current, are carried by the one system, while all the loads of the other are direct currents or alternating currents of another frequency than 25 cycles.

At the beginning of the present year the power house of the Niagara Falls Hydraulic Power and Manufacturing Company contained one penstock loaded with wheels and generators and one comparatively new penstock 13 feet in diameter, the largest in the world in point of power output, carrying only one pair of wheels, although fitted with gates for five pairs, this pair of wheels driving only one generator, although fitted with couplings for two. The penstock comes vertically down the side of the cliff, bending around to the horizontal under the

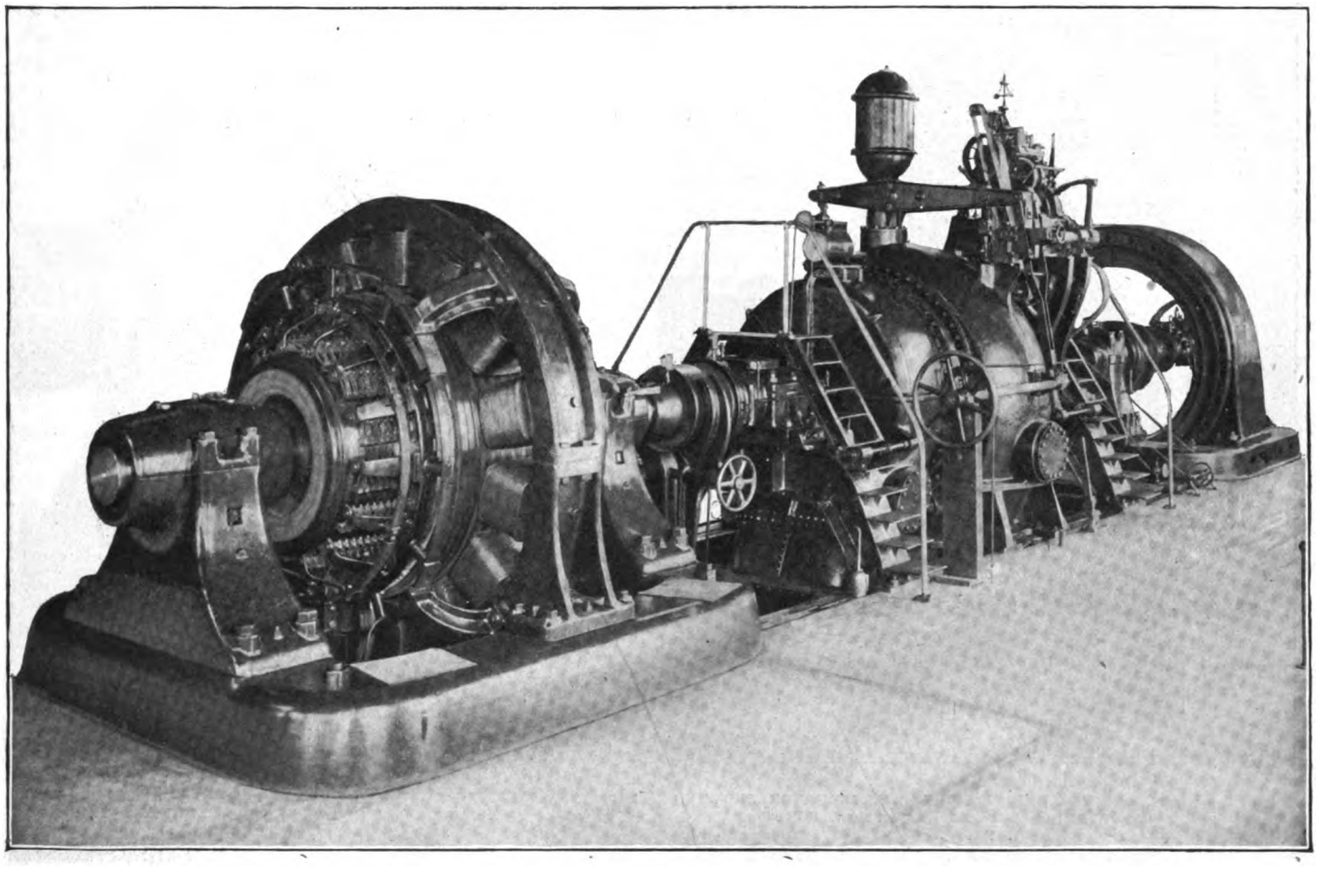


FIG. 1.—A 3000-H. P. PAIR OF TURBINES DRIVING A 5000-AMPERE DIRECT-CURRENT GENERATOR AND A REVOLVING-FIELD, 125-CYCLE SINGLE-PHASE ALTERNATOR.

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power house floor and running straight out across the house toward the river. The inlets for wheels open vertically upward from the penstock, while below it is the tail race. The pair of wheels in service upon this penstock are of the Jonval type—that is, with axial flow through the runners, mounted on a horizontal shaft extended out to take a generator on each end. The wheels are 60 inches in diameter and rated at 3000 h. p. for the two when running at 250 r. p. m. under a head of 210 feet. The speed is controlled by a Reynolds governor.

Coupled to one end of the turbine shaft is a unique generator built by the General Electric Company, and designed for an unusually large current delivery. It is rated at 5000 amperes at only 175 volts, its current being used by the National Electrolytic Company for the production of chlorate of potash in a plant situated at the top of the bluff, nearly over the power house. This machine has two commutators, one at either end of the armature, the two sets of brushes being connected in parallel with each other. The division of the load between the two commutators is ingeniously accomplished by varying the load of one or the other set of brushes. The ratchets and handles for moving the brush-holding rings are shown in the illustration, Fig. 5. The saw-tooth clutch in the center is provided to move the two sets of brushes in unison. The division of the load is indicated by a Weston ammeter appearing in the same illustration, and connected up so that when the load is evenly balanced between the two commutators the needle of the ammeter reads zero, the scale of the instrument reading zero at the center. The shunt cords of this ammeter run to two terminals of a Y-shunt connected up as shown in the diagram, Fig. 2. As long as the current going through the shunt, A B, is the same as that through A C, the drop in both will be the same and there will be no difference of potential between the points, B and C. As soon, however, as one commutator takes more current than the other the equality of the drops in the two paths, A B and A C, is disturbed, giving a difference of potential between B and C which deflects the ammeter in one direction or the other, according to which commutator is taking the heavier load.

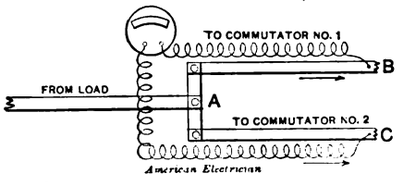



FIG. 2.—DIAGRAM OF Y-SHUNT CONNECTIONS.

During the past year there has been added to the plant an alternator which is coupled to the other end of the shaft of the same turbines which drive the double-commutator machine just described. This alternator is used for incandescent lighting and is owned and operated by the Buffalo and Niagara Falls Electric Light and Power Company. The machine is of interest from the fact that it was built by the Walker Company under a contract and designs drawn up shortly before the consolidation with the Westinghouse Company. It is the largest of the few alternating-current machines built by the Walker Company between the time this company decided to build alternators and the time of its absorption by the other company. The machine is also of interest from the fact that it is single-phase and high frequency, all other large alternators recently built being polyphase and with a frequency at the most of 60 to 66 cycles. The number of poles in this alternator is 60, giving at the normal speed of 250 r. p. m. a frequency of 15,000 alternations per minute, or 125 cycles per second. The field is the revolving member and to avoid crowding the large number of poles, the diameter of the air gap has been made large, some 9 or 10 feet, giving a peripheral velocity of approximately 7500 feet, or 1½ miles per minute.

The exciting current used in this machine is astonishingly large, being at no load 150 amperes, at nearly the same number of volts, amounting to 20 kilowatts, or about twice as much as is used, for example, in the famous 5000-h. p. Ni-

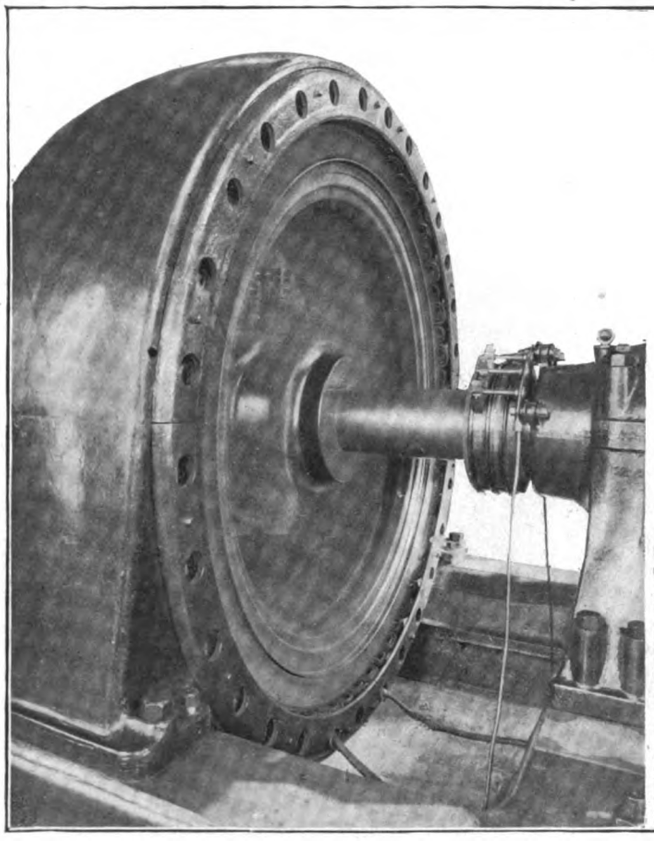


FIG. 3.—A VIEW OF THE HIGH FREQUENCY ALTERNATOR, SHOWING THE WINDING AND THE CLEARANCE FOR REPAIRS.

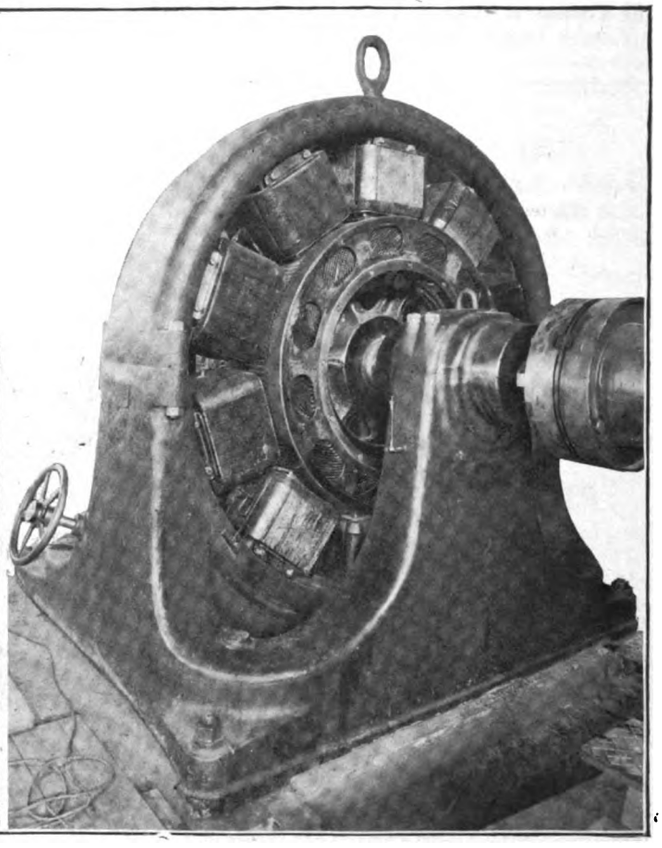


FIG. 4.—A VIEW OF ONE OF THE NEW MACHINES FOR THE PRODUCTION OF ALUMINUM, SHOWING THE COUPLING AND THE ARMATURE PROTECTION.

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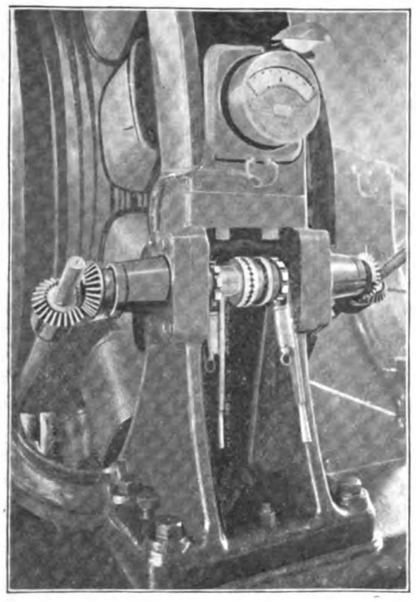


FIG 5.—THE BRUSH-ROCKING MECHANISM OF THE DOUBLE-COMMUTATOR MACHINE.

agara machines. This extremely large exciting current is due in part to the large number of small poles and in part to the high frequency, which requires a very stiff field to obtain a respectable regulation.

The winding of the stationary armature is distributed in four slots per pole, spread over 60 per cent. of the polar pitch, every fourth armature tooth being much wider than the others. The winding consists of one path from terminal to terminal, all the turns being in series with each other, the coils being distributed on the spiral or pan-cake fashion, as indicated in Fig. 3. As the same cut shows, there is a large clearance between the armature and the journal at the collector ring end. This is given to allow the stationary armature to be moved along the base until it clears the rotating field.

The machine is excited by a small four-pole Walker machine belted to it, the only peculiarity of this exciter being its rated pressure, which is 185 volts. By adopting this pressure, the alternator may conveniently be excited from the large electrolytic generator driven by the same wheel, in case the exciter fails.

The alternator was built for 700 kw., but tests upon it show that its best efficiency is given at about 900 kw., and that it will stand this load continuously without overheating. The Walker Company evidently wanted to be on the safe side in building a new machine and did not stint material and run the risk of rejection of the machine after test.

The switchboard panel of the generator is an unusual aggregation of apparatus from various makers, in spite of which it presents a very creditable appearance, as Fig. 7 shows. At the top of the panel are two Wagner instruments of the oil flotation type, for indicating the a. c. voltage and amperage. Below are a Weston round-type ammeter for the field and a Westinghouse integrating wattmeter to give a record of the kw. hours. The main field rheostat is Cutler-Hammer, the exciter rheostat is iron clad, and a Stanley transformer is used for pilot lights. A special and unusually handsome I. T. E. circuit breaker is the central figure on the panel. As may be seen in the illustration of the board, the tripping coil of this breaker is back of the panel, the front of the instrument consisting of four carbon breaks in series with each other at the top, shunted by a U-shaped knife below them. The breaker is single pole.

There has also been installed during the past year in the power house a 200-kw. 135-volt shunt-wound generator, made by the General Electric Company, the current from which is used by the Alloy Smelting Company in a secret electro-smelting process for the production of chromium. This machine is belted to a turbine on the old penstock, which turbine also drives a railway generator and a 500-volt machine on a motor load.

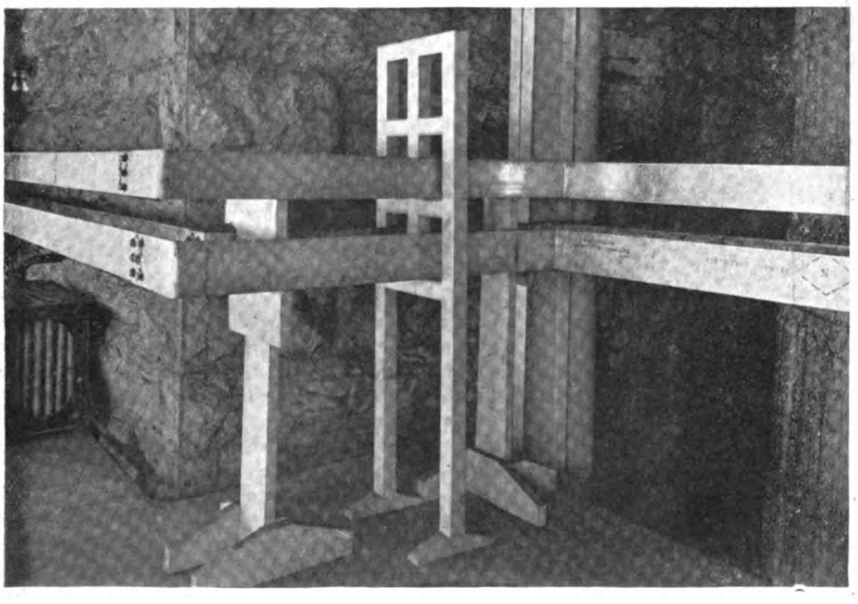


FIG. 6.—SOME ALUMINUM FEEDERS RUNNING TO ELECTRO-CHEMICAL ESTABLISHMENTS.

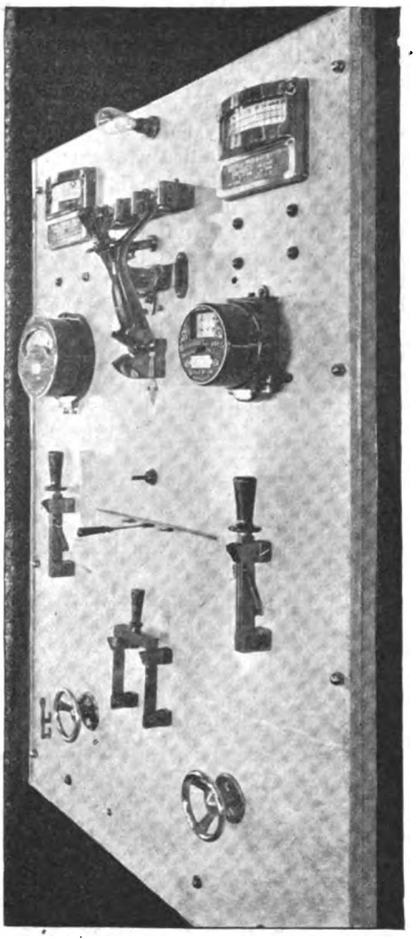


FIG. 7.—THE SWITCHBOARD OF THE ALTERNATOR.

There has also just been completed a new equipment of generating machinery for the Pittsburgh Reduction Co. to meet the increased demand for aluminum for use in place of copper as electrical conductors. This equipment consists of two pairs of turbines, each pair coupled to two Westinghouse generators. The turbines were built by R. D. Wood & Company of Philadelphia, and resemble closely that shown in Fig. 1. The new ones are, however, somewhat smaller, being rated at only 2300 h. p. per pair, that just referred to being of 3000-h. p. capacity. The new wheels embody some changes and improvements. Like the older ones, they are of the Jonval type, with improvements of Mr. Emile Geyelin, but in place of register gates the new ones have cylinder gates, which intercept the water before it reaches the distributors. While this modification would impair the efficiency at part gate, the machines of the Pittsburgh Reduction Company, as a rule, run steadily day and night under full load, besides which efficiency at part gate is no object in this plant. The cylinder gates cut off the water before it enters the distributors or guide chutes, and the whole area of passages through the runners remains open at all times. Thus on part gate the effective head upon the runner is reduced and the output of the wheel falls

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off much more rapidly than does the flow of water. On this account the necessary motion of the gate for a given range of load is greatly reduced and the governing is correspondingly easy. These wheels will be governed by hand, no automatic governors being installed with them.

Since the water flows radially through the gates and axially through the runners it makes a quarter turn in the distributors on its way from the gates to the runners. The distributors are properly shrouded to deflect the course of the water in this way.

The cylinder gates of the new wheels are moved in and out toward or away from each other by cranks on vertical shafts, which are turned by a screw and nut mechanism, to be mounted on top of the unfinished wheels shown in Fig. 8.

The new wheels have also an improved form of thrust block. In the older 3000-h. p. unit the thrust blocks are of Babbitt metal mounted between the two bearings that come between the turbine and each generator. The adjustment of the shaft axially is made by means of bolts and nuts on rotating collars. Hence the machine must be shut down once every few months for this adjustment. With Jonval type wheels any axial displacement will cause the runners to strike the distributors. Whenever the thrust bearings wear the play must be taken up. This adjustment is likely to necessitate the shutting down of the machine at any time. The thrust blocks of the new machines are within the wheel case and are made of lignum vitae and lubricated by the water like the step commonly used between the two turbines of a pair. They are adjustable while the machine is running.

The wheels drive the generators through couplings of a special design, such that they can be uncoupled in a few moments' time. This coupling consists of a disc carrying a key which runs diametrically across the shaft. The key lies in two keyways, one in each half of the coupling. The disc and one end of the key may be seen in Fig. 4. The driving is all done through the key, so that the only bolts that are needed are two small ones to prevent the disc from slipping out of place. These can be removed in a very short time when it is desired to uncouple.

The reader may remember that the old machines of the Pittsburgh Reduction Company had couplings between the wheels and generators that were flexible in the sense that they contained springs through which the power was transmitted, these springs yielding with increase of load. The new machines have solid couplings, this flexibility being found unnecessary, especially with such a steady load as the aluminum process gives. The flexible couplings have also been removed from the old sets and solid couplings substituted, as the former appeared to cause heating and burning of the lignum-vitae steps between the turbines.

The new generators driven by these wheels are rated at 750 kw. each, being designed for the delivery of 2500 amperes each at 300 volts. They differ but little from the original machines of the same make installed some years ago for the same service. The only visible improvements made in these machines during the last few years are the support of the brush-rocking ring from the field yoke instead of from the outboard bearing, and the use of a protecting plate over the end connections at the back of the armature, as shown in Fig. 4.

In addition to the machinery just installed, and described above, there are under order two other pairs of wheels rated at 3000 h. p. per pair, which will be placed on the last two outlets of the big penstock. These wheels will be of a still

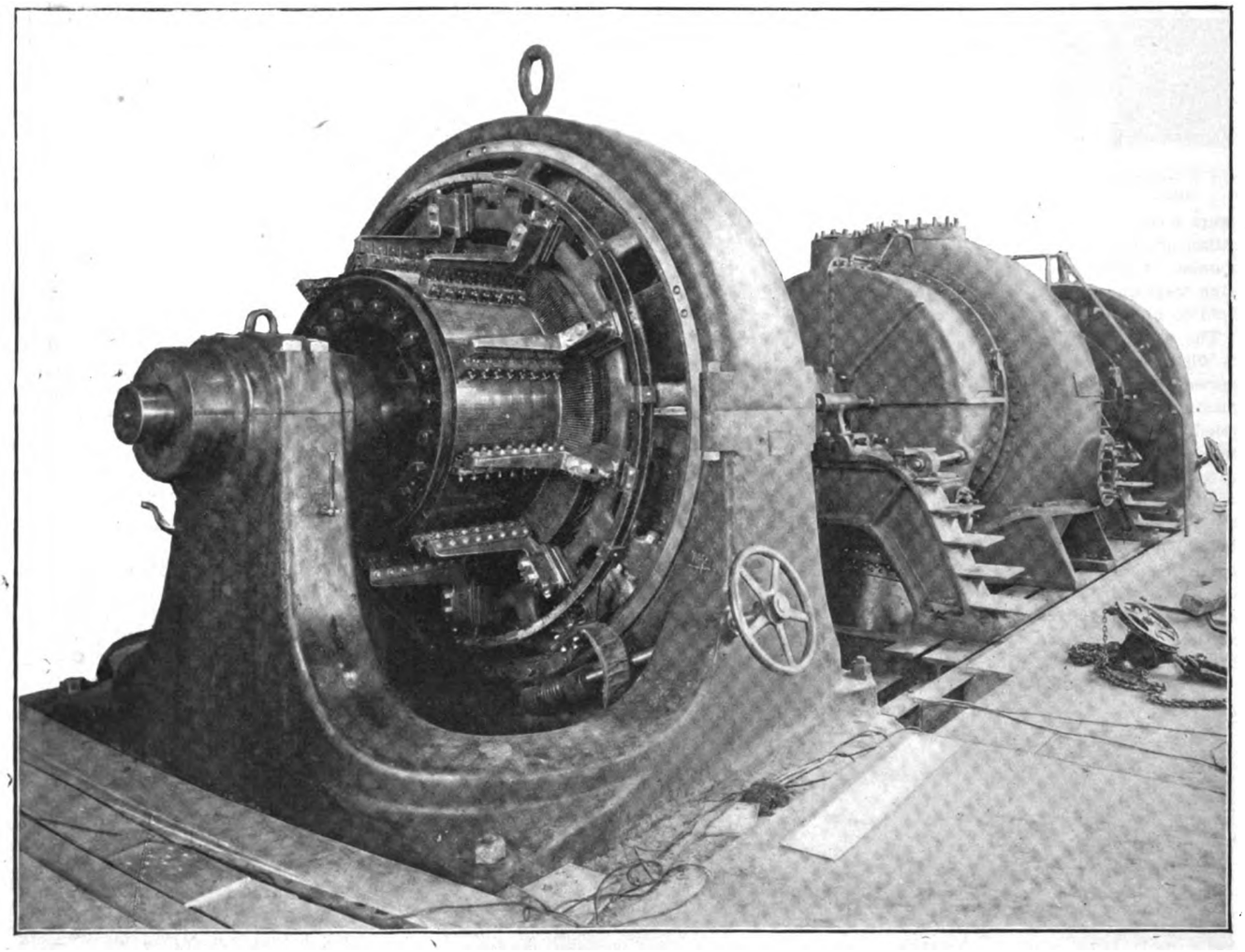


FIG. 8.—ONE OF THE NEW PAIRS OF TURBINES AND 300-VOLT GENERATORS OF THE PITTSBURGH REDUCTION COMPANY.

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different type from any now in use in this power house, being designed on the more common inward radial flow principle. They are being built by the Wm. Cramp & Sons Ship & Engine Building Company, Philadelphia, commonly known as Cramp's shipyard.

These new turbines will drive another 5000-ampere machine for the National Electrolytic Company, a duplicate of the double-commutator machine described above, and three 1000-kw. 325-volt General Electric machines, which will deliver current to the Acker Process Company. This current will be used for the electrolytic production of alkalis from common salt, but the process will be unique in that the baths will not consist of salt in an aqueous solution, but of fused or molten salt maintained at the proper temperature by means of the $C^2R$ losses of the high current density within it.

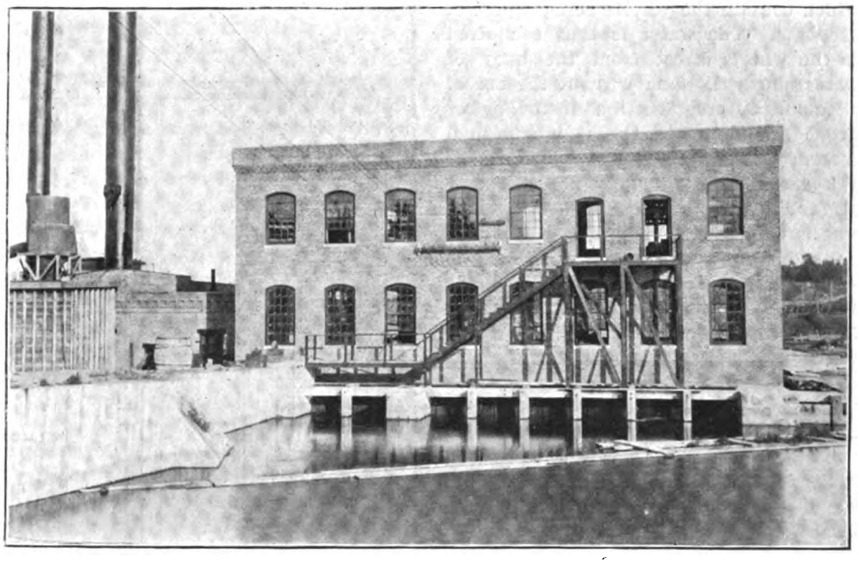
The power house now contains altogether the following equipment of machines:

| | Kilowatts |
|---|---|
| Six old 280-volt, 2000-ampere generators for Pittsburg Reduction Sompany..... | 3360 |
| Two 560-volt, 1000-ampere generators, one on railway and one on motor loads.... | 1120 |
| One railway booster..... | 75 |
| One 175-volt, 5000-ampere machine for the National Electrolytic Company..... | 875 |
| One 135-volt, 1480-ampere machine for the Alloy Smelting Company..... | 200 |
| Four new 300-volt, 2500-ampere machines for the Pittsburg Reduction Company. | 3000 |
| One 2200-volt, 410-ampere, single-phase alternator for the Buffalo & Niagara Falls Electric Light & Power Company ..... | 900 |
| One exciter ..... | 30 |
| Total present capacity of plant..... | 9560 |

To provide for further increase of business in future, work has already been started on a new penstock to the right of the present one, as looked at from across the river. This new penstock will be a duplicate of the last one, and hence capable of delivering 12,500 h. p. with a very moderate velocity.

The canal of the company, from the river, above the rapids, through the town to the penstocks running down the side of the cliff, has been enlarged during the past year, so that there is now a channel 14 feet deep and with a width of 40 feet. The company possesses the right to draw all the water it can through a channel of this depth and 100 feet wide. With the very moderate fall of 2 feet such a canal would pass sufficient water to generate, under the head obtainable, over 100,000 h. p., that is to supply eight or ten such penstocks as that recently built and that about to be put up. If present indications are correct, the construction of these penstocks will proceed in quick succession until all are in place and use. The water front for about a mile along the gorge is owned by this company, giving ample room for a very large equipment of penstocks and wheels. By increasing the fall in its canal slightly the company can, when future demands warrant it, generate many hundreds of thousands of horse power.

For the information given above thanks are due Mr. W. C. Johnson, the hydraulic engineer in charge of the whole work, to whom credit is also due for the solutions of many original problems, some of which are mentioned above.

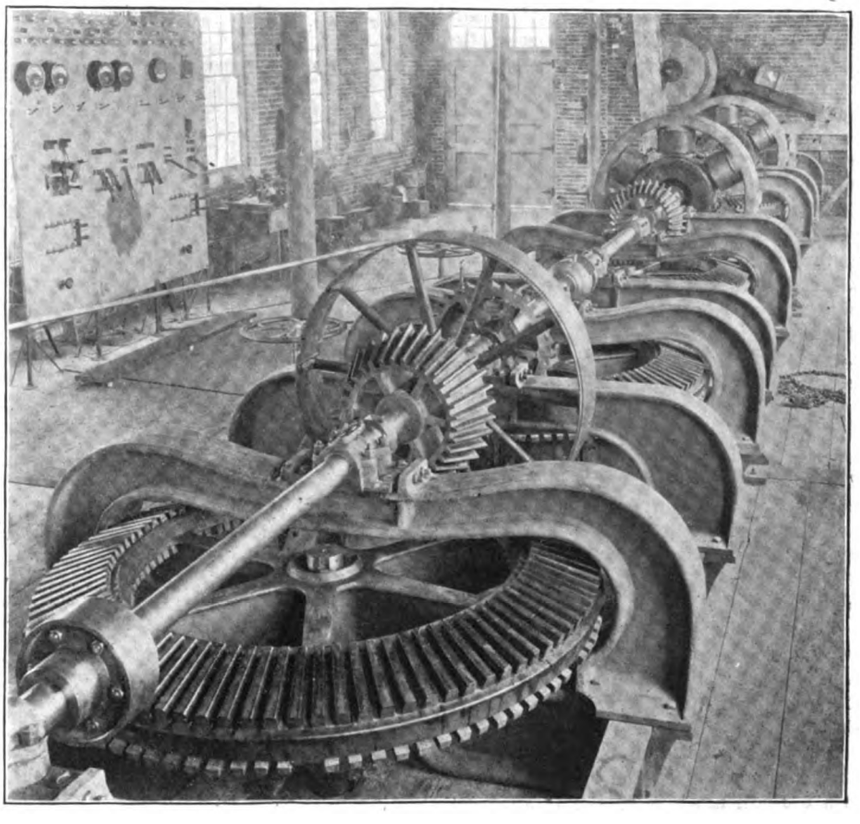


# The Power Plant of the Merrill Railway and Lighting Co.

BY F. E. WOODFORD.

To build a power and lighting station in a small city where it is expected that the number of consumers will be somewhat limited, it oftentimes becomes a problem to arrange the equipment to meet the variety of demands upon it, and still have it so simple and compact as to run on an economical basis. It is of course desirable to have the generating units as large as possible, and as few in number.

The new plant of the Merrill Railway and Lighting Company of Merrill, Wis., presents a unique arrangement of a combined hydraulic and steam power station with several turbines and generators on one shaft for both incandescent lights and electric railway service, delivering direct current only at one voltage. The power house, a view of which is shown above, is built on the river side, the flumes



THE INTERIOR OF THE MERRILL POWER HOUSE, SHOWING THE GEARS.

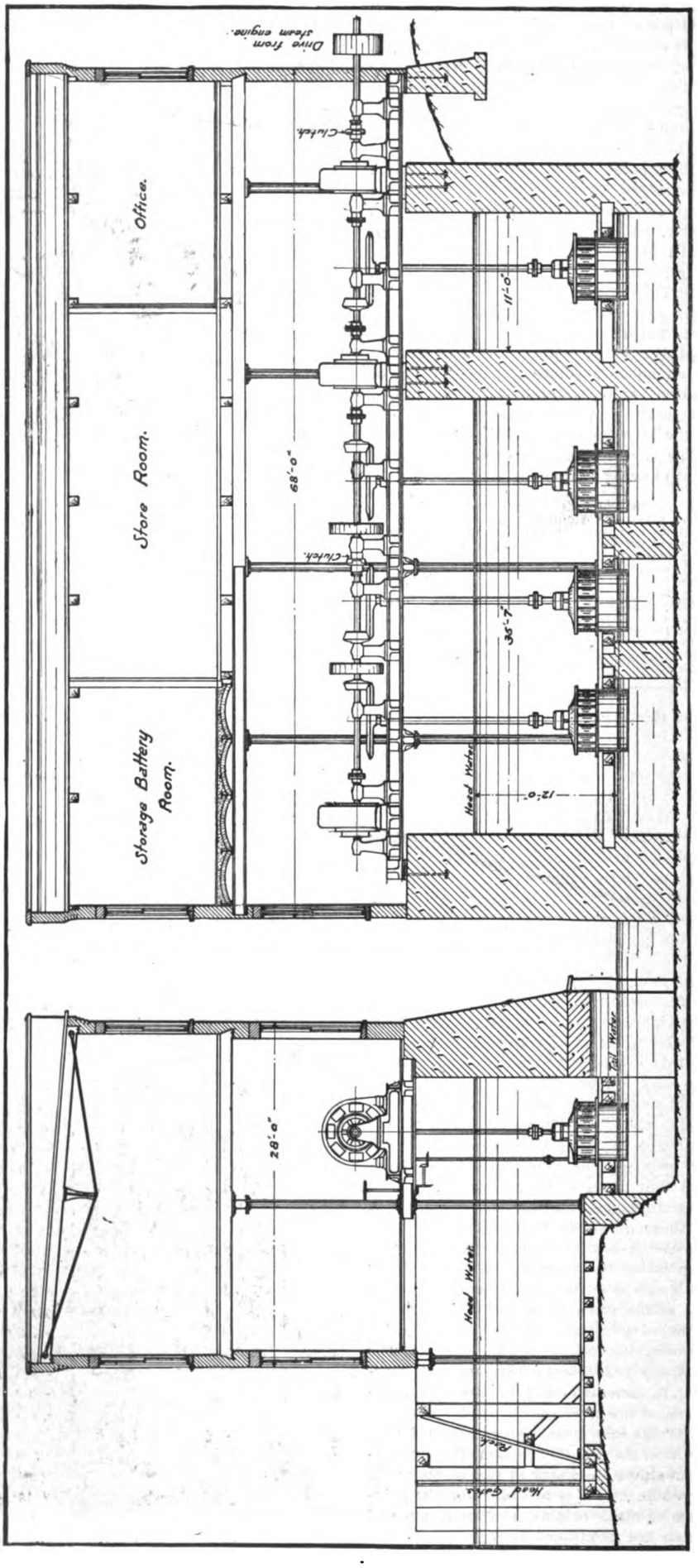
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which contain the wheels being a part of the dam. The water is thus conducted to the wheels direct from the body of water above the dam without the use of a canal. A cross section of the power house is shown with a longitudinal section on this page. The bed of the Wisconsin River at this point is nearly all solid rock, consequently excavation was unnecessary except to a depth sufficient to allow a free discharge from the wheels. Upon this rock bed are built the walls of the flumes which also form the foundation for the building proper. These walls are of stone laid in cement, the outer ones being 6 feet and 7 feet thick, with the partition walls 4 feet thick. The building is of brick, two stories in height, the lower story consisting of one room 68 feet long and 28 feet wide, in which the generators and switchboard are placed. The upper story is divided into three rooms. The outer one toward the river end is provided with a concrete floor and contains the storage battery plant. The middle room is used as a store house, while the end away from the river has been fitted up for an office.

On the land side of the main building and not connected with it, except by a covering for the belt way, is the steam engine and boiler room, with its equipment, which is not shown in the section.

The wheels are 42-inch new American, of the upright type, and under the head of 12 feet they run at a speed of 102 r. p. m. Directly above the wheels, and resting on the stone walls, is an iron harness extending the entire length of the building. This harness forms the foundation of the three generators shown in the section, and also the cast-iron yokes which take the bearings of the shaft. As will be seen, the four wheels are geared to a horizontal shaft extending the entire length of the harness, and upon this shaft are mounted the armatures of the generators. The shaft extends through the end of the main building, at which place power is applied to it from the steam engine. There are two clutch couplings in this shaft, one at the end of the building, which cuts off the engine, and the other cutting off the outer generator and that part of the shaft driven by the two outer wheels. By this arrangement two wheels may be run, driving two generators, or the other two may be run driving one generator. Or, at a time of low water, two or all of the wheels may be run in connection with the engine. Three of the wheels are placed in one flume, while the fourth is separated from the rest by a partition wall, so that any repairs may be made without shutting down the entire plant. A view of the harness and gears is shown on page 551.

The generators are of the General Electric Company's manufacture, the two toward the land end of the plant being 100-kw. each, 250 volts, and running at a speed of 300 r. p. m. They are connected in series and feed into the storage battery in the room above. The other generator is a 500-volt machine at the same speed,




CROSS AND LONGITUDINAL SECTIONS OF THE MERRILL POWER PLANT, SHOWING THE ARRANGEMENT OF THE TURBINES, GEARING AND DYNAMOS.

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and when run operates in parallel with the other two.

The storage battery plant consists of 240 cells of 500 ampere-hours capacity. With the exception of the series arc lamps, all power and lighting current is taken from the storage cells.

During the day the street railway and the shop motors compose the load, as a day lighting circuit is not run at the present time. The street railway is two miles long, and runs two, sometimes three, cars of eight tons each, which take an average of from 20 to 30 amperes. The other motors require about 40 amperes, so the load all day does not exceed an average of 70 amperes.

The lighting current is taken by five wires from the battery, and delivered by separate circuits to the different parts of the town. The heavy lighting load occurs between seven and ten o'clock at night, and this added to the street railway equals 200 to 240 amperes, the maximum number of lights being 1500.

The generators run all day with scarcely any adjusting, delivering the average amount of current required, the battery taking any excess and supplying any shortage. At night some adjusting of the water wheel gates is needed when the lights are thrown on, and from ten to twelve, when the lights are being turned off, the generators and wheels require a little attention.

The two arc machines are at the up-river side of the building, and do not show in the section. They are belted direct from the shaft on which the armatures of the other generators are mounted.

The storage battery is a perfect governor. The three direct-connected generators and two arc machines are run upon the same shaft, under a varying load, and while there is no balance wheel on the shaft, it is not necessary to govern the speed except by hand.

The steam engine in connection with the plant develops 250 h. p. at 90 r. p. m. Under the present conditions it is necessary to run the engine only at a time of extremely low water, or in case of some repairs being made to the flumes or wheels. In fact, it has not been in use at all as yet. But while the plant is built in excess of the present needs of the town, it is expected that the demands upon it will keep increasing until the engine will be needed as an auxiliary during heavy load.

The operation of the plant is extremely simple, requiring only one attendant at all times. It has been in operation for over a year, giving the best of satisfaction to both the owners of the plant and the consumers of its power.

# The Design and Construction of a Modern Central Lighting Station.*

BY H. H. HUMPHREY.

An ordinance, passed by the Municipal Assembly of the city of St. Louis, Mo., in the fall of 1896, threw open the doors to all applicants for underground conduit rights. Among the applicants were several newly organized companies, and one of them has since constructed its plant. The Imperial Electric Light, Heat and Power Company first turned current into its underground system one year ago, October 15, 1898, and has been in continuous and successful operation since that date. This paper is a discussion of the design and construction of this plant, which embodies many interesting features.

This plant was intended primarily to compete for business in the down-town or underground district of St. Louis. It was required, however, that the system adopted should be capable of being extended beyond this district, and, if necessary, of covering almost the entire city. The success of the three-wire direct-current low-tension underground system in this and other countries naturally influenced the engineers in its favor. On the other hand, the cost of copper for such a system, while not strictly prohibitive, is still so large as to demand most serious study.

The class of service to be supplied had great weight in the final decision regarding the system. This service consists largely of 500-volt direct-current motors, there being also some 220-volt motors of smaller size. Another important part of the service was to be arc lighting. The growing popularity of the inclosed arc lamp indicated that this field would be very profitable. The furnishing of incandescent light was by no means of secondary importance. In order to reduce the first cost of station equipment and underground work, both conduits and cables, it was deemed advisable that all three kinds of service should, if possible, be supplied from one generator, delivering its output through one underground duct and one service cable.

These considerations led to the adoption of a three-wire direct-current system of distribution, differing in important details, however, from the methods heretofore employed. 220-volt incandescent and 220-volt arc lamps were both to be used on the sides of the three-wire system, while 500-volt motors would be connected directly across the outside wires. The saving in copper over the usual 110-220-volt system, based upon the same percentage of drop, is three-fourths. Furthermore, the area which can be supplied from one central station at the same percentage of loss is increased sixteen times. If in the 110-220-volt system the limit with a certain drop be placed at one mile from the station in all directions, an area of 3.14 square miles can be covered. With the 220-440-volt system the distance reached from the station in all directions is four miles, covering an area of 50.24 square miles. By the proper use of boosters with storage batteries at the ends of feeders, such a system may be extended over a district within a radius of 10 miles from power plant.

The next question in point of importance was the location of the plant. It would be natural to assume that such a plant should preferably be located upon the river front in order to secure cheap water, and upon a railway switch to secure cheap fuel. In this case, however, no suitable property was available on the water front. Furthermore, fuel coming from Southern Illinois district can be delivered by wagon from East St. Louis almost as cheaply as when bridge and

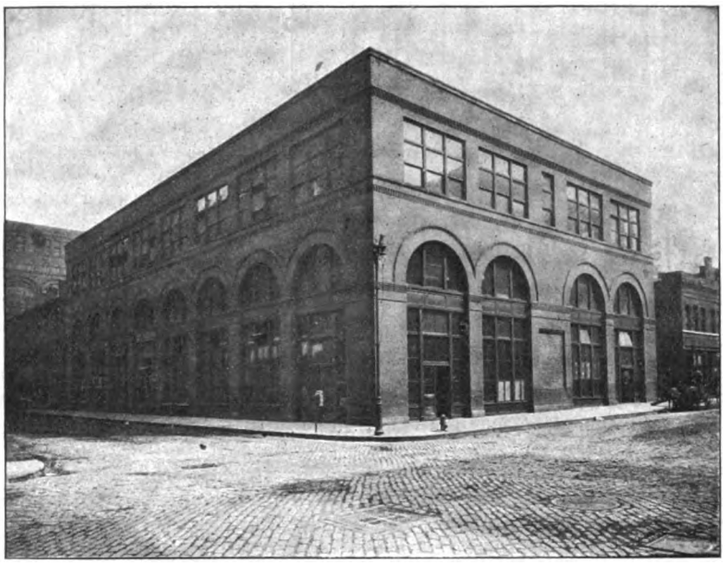


FIG. 1.—EXTERIOR VIEW OF IMPERIAL STATION.

*From a paper read before the Engineers' Club of St. Louis, Oct. 18, 1899. Slightly abstracted. Illustrations from Proceedings Association of Engineering Societies.

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switching charges are paid on carload lots unloaded at the plant. Very few St. Louis power plants are located upon railway switches, and one large plant, which is so located is supplied with coal hauled in wagons from East St. Louis. Under these circumstances the plant should be placed as near the electrical center as possible. A suitable lot was found at the southeast corner of Tenth and St. Charles streets, and the plant was located there.

The designing of a plant which would ultimately utilize to the best advantage all the limited space available was next undertaken. Before entering upon the details of this work, however, one of the engineers spent some time on an extended trip through the East visiting the large power plants in New York City, Boston, Pittsburg, Philadelphia, Buffalo and Chicago, making a study of the most modern plants in these cities. After much study it was decided to locate the boilers, dynamos and engines all upon the street level, rather than place part of the apparatus below street level, as is frequently done. A study of many different designs led to the division of the plant longitudinally, east and west, into an engine room and a boiler room, each extending the full length of the property; this plan giving an ultimate capacity of 10,000 h.p.

Hypothetical load curves were next prepared, covering the service expected from this plant, including incandescent and arc lights and motor service. The three were then combined into one curve representing the entire anticipated output of the plant under the heaviest service of the winter months. A study of this curve indicated that the number of units in the plant should be at least five. This number fitted both the minimum load, which was about one-fifth of the maximum, and provided admirably for reserve. In case of accident during the peak of the load, the other four units could take the place of the disabled one by each carrying 25 per cent. above its rating. In case of the adoption of a storage battery sufficiently large to carry the reduced load during the latter part of the night, and assist the generators during the times of maximum load, it was deemed safe to reduce the number of units to three, the battery to be of the same capacity as each of the units.

In designing the steam plant it was necessary to determine beforehand what economical auxiliary apparatus, if any, should be installed in connection therewith, as all of these affect the capacity of the boiler plant. The rule adopted by the engineers in determining whether any species of economical apparatus was worth installing was that it should be able to earn, under a conservative estimate of the conditions of service, and taking into consideration the low price of fuel in this territory, 18 per cent annually upon its first cost.

Applying this rule to the consideration of compound versus simple engines resulted in favor of the compound engine. A further comparison between compound non-condensing and compound condensing engines showed the ultimate economy to be in favor of the condensing type. Economy in the use of water, which is obtained from the city's mains at considerable expense, necessitated the installation of a cooling tower in connection with the condensing plant. The application of the above rule to the question of fuel economizers showed that they would be a good investment.

It was decided to use water tube boilers, as this type gives large capacity in small space, is absolutely safe, quick steaming, economical in fuel and can be had in large units. With good draft they may be overworked 50 per cent., and under mechanical draft they may be operated for short periods at double their rating. Down draft furnaces, of the type which has proven so successful in St. Louis, were selected. They are capable of burning low grade coal, running high in moisture and clinker, and may be overworked far beyond the rating of the boilers. They are also simple, easily repaired and not likely to get out of order. The most important characteristic, however, is that they are smokeless, thus complying with the city ordinances. They improve the fuel economy, and add somewhat to the boiler's capacity.

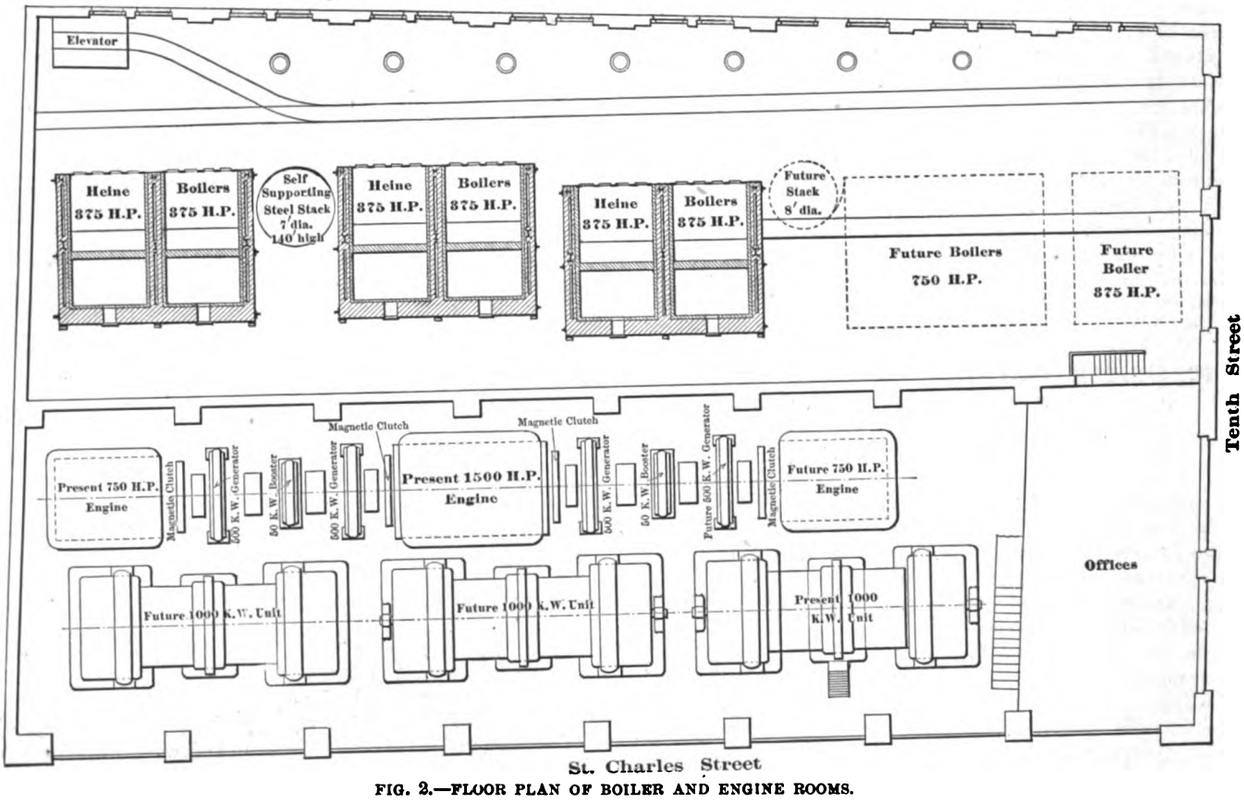



FIG. 2.—FLOOR PLAN OF BOILER AND ENGINE ROOMS.

It was decided at the outset to divide the total chimney capacity into two units, for the reason that the draft would be better at light loads, and one stack only needed to be built then, as but a part of the plant was to be installed to start with.

On account of the use of the 220-440-volt system of distribution and the many economical features of the steam plant, this station has attracted unusual attention. A detailed description of the apparatus used therein may therefore have more than passing interest.

BUILDINGS.

The building is of dark red brick, three stories high above the basement. The area under sidewalks on both streets is

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excavated to the curb line, which forms the outer line of retaining wall. The second story is omitted everywhere except over the main office, thus giving a clear height in the engine and boiler rooms of 30 feet. The third story, which is 15 feet high, is devoted to store rooms, testing department, etc. All floors are of cinder concrete carried on corrugated iron arches sprung between I beams. The roof is of book tile with composition gravel covering. Engine and boiler rooms are separated by a division wall having fire doors at all openings. Beneath the engine room are the storage batteries, extending partly under the sidewalk. Beneath the boiler room is space for coal storage, ash handling and the location of condensing apparatus and piping. The floor of engine room is laid with hexagonal tile, and the walls for 6 feet above the floor are wainscoted with marble. The main offices of the company occupy the Tenth and St. Charles street corner on the first floor. The private offices are in the second story, directly above. An elevator at east end of the boiler room runs from basement to third floor.

BOILERS.

There are four Heine boilers, Fig. 4, arranged in batteries of two each, with one stack between them, and economizers in the rear of and above the boilers. Each boiler has a rated capacity of 11,250 pounds of water per hour with feed water from the economizers at 200° F., into dry steam of 175 pounds pressure above atmosphere, and is guaranteed to be capable of developing continuously one-third more. Efficiency guarantee is 70 per cent of the calorific value of the coal at any load between rating and 20 per cent above. This is equivalent to evaporating 7.21 pounds of water per pound of Mount Olive nut coal of 10,600 B. T. U. The boilers are tested under a hydrostatic pressure of 250 pounds. The entrainment is guaranteed to be less than 1 per cent at rating, and not more than 1½ per cent at one-third above rating. A feature of the furnaces which is original with the engineers is making the firedoors open the full width of the furnace, greatly facilitating inspection and care of the fires. Two additional Heine boilers of the same capacity are now being installed.

Connected with the system is an improved draft gauge by which the draft can be read to thousandths of an inch at eight different points, including ash pits of four boilers, two breechings, inlet to draft fan and base of stack.

MECHANICAL DRAFT.

In order to counteract the effect of the economizers in cooling the gases from the boilers, and to permit crowding when necessary, a mechanical-draft system was installed. It is of the induced type, the fan being placed directly behind the stack and between the two batteries of boilers. The bearings of the fan are self-lubricating and water cooled. This fan is driven by means of a direct-geared electric motor, designed to be operated at different speeds on either the 235- or 470-volt circuit. The motor is to be controlled automatically, so as to maintain the steam pressure practically constant, the regulator slowing down the motor as the steam pressure rises and increasing its speed as the pressure falls. The capacity of the fan is sufficient to handle the waste gases from four boilers and furnish a draft equal to one inch of water where the gases leave the boilers. It is capable of being speeded in emergencies sufficiently to give a draft of 1½ inches on all four boilers.

FUEL ECONOMIZERS.

There are two Green fuel economizers, capable of heating regularly and continuously 45,000 pounds of water per hour 100° F. when receiving the water at 110° F., and with the temperature of the escaping gases leaving the boilers at not less than 450° F. One-third more water may be passed through in case of necessity, but

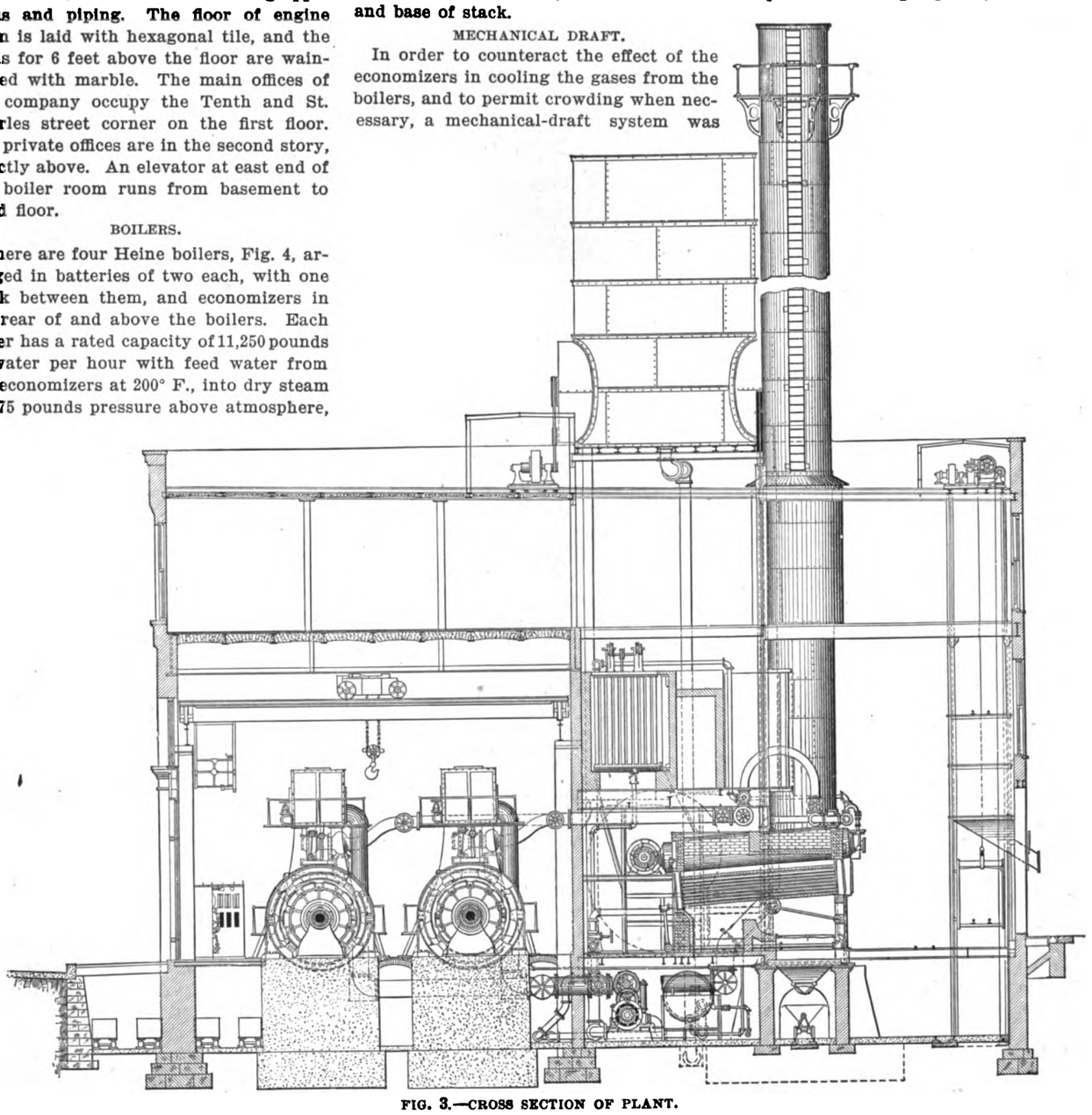


FIG. 3.—CROSS SECTION OF PLANT.

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of course with diminished economy. These economizers are designed for a working pressure of 200 pounds per square inch, and were submitted to a hydrostatic test of 300 pounds after erection in position. They are provided with automatic scrapers operated by electric motors. The economizer plant is provided with pop safety valves, necessary deflectors, soot scrapers, doors, dampers, etc. They have pressure gages at feed-water inlet, also feed-water thermometers located one in pipe at entrance to economizers and one in pipe where water leaves the same; also two gas flue thermometers reading to 1000° F. in smoke flue; one where gases enter economizers, and one where they leave. The necessary dampers are provided for sending the gases from the boilers either past the economizers and directly out the smokestack or through the economizers and thence up the stack, or through the economizers to mechanical draft fan and thence up the stack. The economizers are located in the rear and above the boilers, supported upon a substantial iron framework and bricked in air-tight by 8-inch walls.

### COAL AND ASH-HANDLING MACHINERY.

The coal and ash-handling plant is of simple and economical design, and consists of a system of cars, tracks, elevator and overhead ash bin. The cinders and ashes from the lower grates drop directly into a metallic ash hopper under each boiler. Running east and west immediately under these hoppers there is a narrow-gage track. The ashes are dumped from these hoppers into small cars and pushed by hand along the track to an elevator, on which they are carried up and dumped into an overhead ashbin, from which they run by gravity into the wagons in the alley. Any ashes which accumulate in the stacks may be emptied directly in the cars in the same manner.

The entire space in front of the boilers in the basement is reserved for coal storage, the fuel being dumped through openings in boiler room floor. It is taken from this storage room in the same cars, tracks being provided the entire length of the coal storage space. It is then hoisted on the elevator to the floor above and distributed on tracks over the entire length of the boiler room in front of the boilers.

### STEAM ENGINES.

There are now in operation two engines, Fig. 5, of the Williams vertical two-cylinder cross-compound condensing automatic cut-off pattern, built by Wm. Tod & Co., of Youngstown, Ohio, and designed for direct connection to the dynamos and shafting. The east engine, No. 1, is of 750 i. h. p., and is designed for driving one 500-kw. generator at the most economical rating of the engine when operated at a speed of 150 r. p. m., and supplied with steam at 170 pounds initial pressure per square inch at the throttle valve, and exhausting into a 24-inch vacuum. Engine No. 2 has double the capacity, and is similar in design to No. 1. The heavy fly wheels are located between the A frames supporting the high and low-pressure cylinders. Each engine is so constructed as to be capable of operating continuously at double its rated capacity. and for short intervals only at one-third above its double rated capacity. This additional capacity is obtained by admitting live steam into the receiver or low-pressure cylinder. The high-pressure cylinders are steam-jacketed on the barrel, and both cylinders on both top and bottom heads. The receiver is provided with reheating coils of copper. The main bearings are adjustable, and are provided with water jackets. The guides are water-jacketed on the running side. The cylinders and all bearings are lubricated by the Siegrist lubricating apparatus, which delivers the two kinds of oil to the cups under pressure automatically maintained by duplicate steam pumps. They also have hand oil pumps for additional safety. The cylinders have flat multiported valves driven directly from the eccentrics. The clearance is guaranteed not to exceed 6 per cent in either cylinder. These engines are provided with shaft governors operating upon the valves of the high-pressure cylinders, and capable of varying the cut-off from 70 per cent of the stroke back to minus 3/16-inch opening. The regulation guarantees are that the drop in speed with a constant steam pressure from no load to one-third above rated load will not exceed 2½ per cent. This guarantee also covers a variation of steam pressure between 160 and 175 pounds with constant load. The variation of speed will not exceed 3½ per cent with the combined changes in load and steam pressure above specified, either with or without the vacuum. The governor is also fitted with a special speeding device by means of which the engine may be brought to the same rate of speed under friction only as under full load. When running with about 170 pounds pressure at the throttle, at 150 revolutions per minute and under a constant load at their rated capacity, the engines are guaranteed not to consume more than 15 pounds of water per indicated horse-power hour.

Another 1500-h. p. engine, designed and built by the Lake Erie Engineering Works, Buffalo, N. Y., has just been installed.

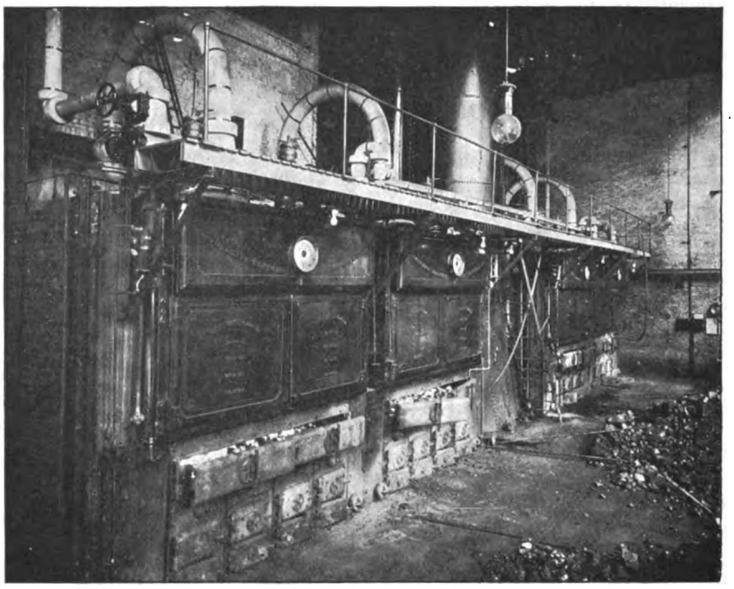


FIG. 4.—FRONT VIEW OF BOILERS.

### CONDENSERS, PUMPS AND COOLING TOWERS.

The condensing plant consists of one Worthington surface condenser, one Worthington cooling tower, two combined air and boiler feed pumps and two circulating pumps of the rotary type. The rated capacity of the plant is 33,750 pounds of steam per hour, but it will take care of overloads up to 49,500 pounds per hour with but slight reduction in vacuum. It is guaranteed to produce a vacuum of not less than 22 inches at above rating and under the worst conditions of service; 25 inches under fair and average conditions, and 26 inches under the best. These conditions vary with the humidity and temperature of the air.

The cooling tower, Fig. 7, located on the roof, is 18 feet in diameter, 29 feet high and its cooling surface is composed of galvanized iron pipe cylinders. It has duplicate fans located on opposite ends of the same shaft drawing air into the tower. These fans are driven by a belted motor in pent house on top of building.

There are two combined air and boiler feed pumps; one of sufficient capacity to handle the water required by the 1500-h. p. engine, and the other of sufficient capacity for the 750-h. p. engine, and two independent rotary circulating pumps of the same capacities. These pumps are driven by direct-geared motors, so designed that the speed may be varied at least 33 1/3 per cent.

There are also two injectors for reserve boiler feeds, each having a capacity of 11,250 pounds of water per hour, and capable of handling water of any temperature below 125° F.

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POWER TRANSMISSION SYSTEM.

The engines and generators are connected by means of the Arnold system of power transmission (see Fig. 5), consisting of quills and internal shafts with double bearings, connected by magnetic clutches. The arrangement is intended to make it possible to drive any one, two or all three of the 500-kw. generators, and either one or both of the boosters, from the large engine in case of accident to the small engine. Two generators and one booster may also be handled by the small engine in case of accident to the large one.

The generators are connected to the engines by means of magnetic couplings, so arranged that either intermediate generator or booster may be disconnected from one engine and connected to the other while all are in motion. When it is desired to start up a generator, it is brought up to speed as a motor and then connected to the engine by the magnetic clutches.

PIPE WORK.

The entire high-pressure system is designed to operate under a working pressure of 175 pounds per square inch, and was tested to 250 pounds hydrostatic pressure. All fittings are extra heavy. All pipe above 3 inches in diameter has flanged couplings and fittings. All bent pipes are made of steel, and bent hot and of long radius. All valves on live steam pipes and on the feed water connections under boiler pressure are bronze seated. All valves above 10 inches in diameter are by-passed. The cylinder jackets, re-heaters, separators, steam headers and the entire pipe system is drained by means of the Holley system, returning the water directly to the boilers. There is a combined hot well and oil filter located between the condenser and boiler feed pumps. All the pipes are covered with magnesia. A steel exhaust pipe is provided for use when condensers are not in service, and extends through the roof near the stack. Each engine has a Cochrane separating receiver located near the main throttle valve. Oil extractors are located between exhaust pipe and condensers. A suitable blow-off tank is provided and connected to boiler furnaces, oil extractors and other hot water drains, with suitable discharge to catch-basin, which in turn overflows to sewer.

CRANE.

The engine room is spanned by an electric traveling crane (shown in Fig. 5) with independent motors on the lifting, traveling and transfer motions. The capacity of the crane is 15 tons at 10 feet per minute, and it has a maximum speed of 30 feet per minute at lighter loads. The maximum speed of travel is 80 feet per minute, and the maximum transfer speed 40 feet per minute. The motors are of 20, 15 and 5 h. p. respectively, and are designed by the manufacturer as a part of the crane and built substantially into the framework of the structure. This crane has proved itself one of the most useful appliances about the plant.

GENERATORS AND BOOSTERS.

There are three 500-volt generators, built by the Siemens & Halske Electric Company of America, of the internal iron-clad-armature type. They are designed specially to fit the system of power transmission adopted. The field frames of the generators may be slid parallel with the shaft a sufficient distance for reaching the armature for repairs. The capacity of each generator is 500 kw. at 525 volts when operated at 150 r. p. m. At this rating the rise in temperature of the armature will not exceed 40° C.; of the field, 35° C.; of the commutator, 50° C. The generators are guaranteed for an overload of 25 per cent. for two hours, and 33 1/3 per cent for one hour, with a 50 per cent momentary overload without injurious sparking. They will not flash at the commutator when the circuit breaker opens at 50 per cent overload. The commutators are of large diameter, insulated with mica and designed for carbon brushes. The brushes are proportioned for 25 amperes per square inch of contact with rated load and have hand wheels for both adjusting and lifting. One megohm of insulation resistance is specified between conductors and frame. The guaranteed efficiencies of these generators are as follows:

| | |
|---|---|
| At ¼ load | 88 per cent. |
| At ½ load | 92½ " |
| At ¾ load | 93½ " |
| At full load | 94 " |
| At 25 per cent. overload | 93 " |

There are two separately-excited shunt-wound boosters, each of 50-kw. capacity at 150 r. p. m., and capable of carrying 500 amperes and delivering any voltage from zero to 130 volts. The boosters are of the same general construction and design as the generators, except that the field frames are divided vertically. Two more generators of the same capacity are being made at present by the same company.

SWITCHBOARD.

The plant contains a composite switchboard, Fig. 6, of 2-inch black marbleized slate, containing three generator panels, one booster panel, two battery panels, one wattmeter panel, three feeder panels and one voltmeter panel.

There are four bus bars on the switchboard; one high positive, one low positive; one high negative and one low negative. There are also positive and negative charging buses. The generators are so arranged that each generator may be operated on either high or low bus bars, either in multiple or separately. Each of the two end-cell switches on each end of the battery may connect either to the high bus or low bus, or to the charging bus. The two boosters in the plant may each be connected either between high bus and charging bus, low bus and charging bus, or between low bus and high bus, on either side of the system. The boosters may be connected in series either between low positive bus and neutral or between low negative and neutral. These combinations provide for charging the battery under all conditions of service, and at the same time maintaining it upon the line as an equalizer of the pressure. Also, either side of the battery may be completely disconnected, or the entire battery cut out of service and the balance of the system maintained by means of the two boosters connected together in series and operating between the neutral and either side of the system.

All the electric connections between generator and booster and switchboard are made of asbestos-covered copper cable run underneath the floors and supported upon porcelain holders. The connections between battery and switchboard are made by means of copper bars, lead-covered and painted with an acid-proof paint, and supported upon porcelain racks. The battery is connected through switches to the bus bars and outside circuits without the intervention of either fuse or circuit breaker. Two additional generator panels of the same design have lately been added to take care of the additional dynamos contracted for.

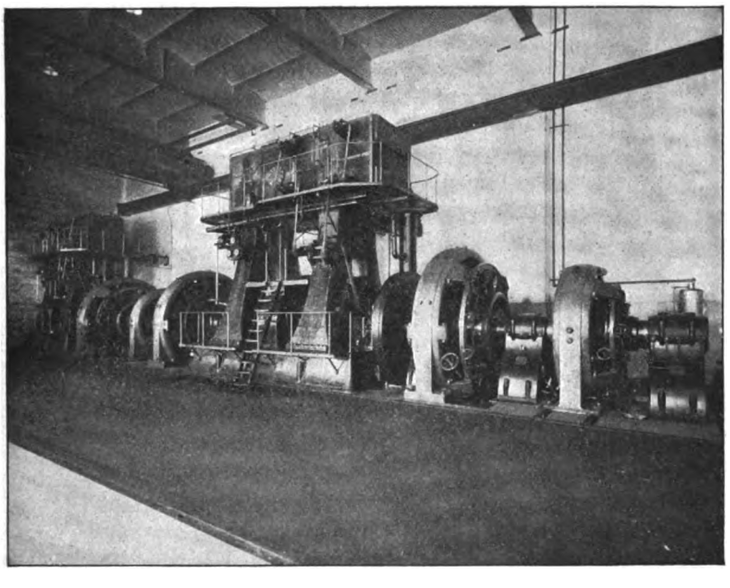


FIG. 5.—ENGINES, DYNAMOS, BOOSTER, MAGNETIC CLUTCHES AND CRANE.

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STORAGE BATTERY.

There are 280 cells of the Electric Storage Battery Company's accumulators, each containing thirteen positive Manchester type plates and fourteen negative chloride plates. These are contained in lead-lined wooden tanks which are supported on large porcelain insulators resting upon 4x6-inch beams. The capacity of this battery is 2000 ampere hours at a discharge rate of 250 amperes, and it is capable of maintaining a maximum discharge rate of 1000 amperes for one hour. It is guaranteed to give a discharge of 500 kw. for one hour without a drop in pressure below 1.7 volts per cell. The normal charging rate is 250 amperes, and the maximum charging rate 350 amperes.

The battery as mentioned above is located in the basement, partly under the engine room, partly under the sidewalk, in a cool, well-ventilated room. The floor is composed of vitrified tile laid in pitch upon a concrete base.

CONDUIT SYSTEM.

Many were the criticisms hurled at the heads of the city officials when they declared that all of the high-tension electric companies should occupy jointly a single conduit system. However, the city proceeded upon this line, and issued conduit rights to all the high-tension companies to the ownership of so many ducts each in a joint underground conduit system occupying one side of the street. On the opposite side the low-tension conduits of the telegraph and telephone companies were placed.

It was feared that the joint building, ownership and maintenance of a conduit system by the high-tension companies might lead to endless litigation, but a liberal application of the golden rule to the grouping of ducts and to the location of service boxes and other engineering details of the work has produced a system of underground conduits which we believe has few, if any, equals.

The high-tension conduit system consists of 3-inch cement-lined pipe laid on 5¼-inch centers, with one inch of concrete between pipes and 3 inches surrounding the entire group. All ducts are laid to drain to manholes. The top layer of ducts enters service boxes, which are of two sizes, 3x3 feet and 3x4 feet. Service boxes are placed at most convenient points for reaching customers, and their depth is governed by the depth of the conduit at each location. Manholes located at every street intersection, and oftener where necessary, are of three sizes, 4x4 feet, with 9-inch walls; 5x5 feet, with 9-inch walls, and 8x8 feet, with 13-inch walls. In depth they are all designed to be 6 feet 6 inches in the clear under the roof. They are connected to sewers wherever sewers could be reached.

The conduits of the Imperial Company as a rule occupy every other street in each direction. They were laid out with the object in view of being able to reach one end of every alley in the city with the distributing main. It was the intention to build service boxes only opposite the entrance of alleys and to distribute entirely through the alleys either by overhead pole lines or through underground distributing laterals. The entire distribution system consists of two ducts, providing one duct for a three-conductor cable and one extra duct for city lighting or other service in the future.

Where feeders were located the number of ducts was increased to provide for them. The system as planned provides for feeders of sufficient size so that one of the largest cables would fill one duct, taking a single cable for the positive and another for the negative sides of the system. A third duct would contain the neutral feeder and pressure wires; another duct to contain the three-conductor main cable, and one duct reserved for future service.

UNDERGROUND CABLE SYSTEM.

While the conduit system provides space for a total of twenty-three feeders, there have been five installed at present. Each feeder consists of two 1,500,000 c. m. single conductor cables and one 500,000 c.m. single-conductor cable for the neutral wire. A pressure wire of No. 16 three-conductor cable carried in the same duct with the neutral, and connected to the ends of the feeder, provides means for measuring the pressure at the feeding point by a voltmeter located at the plant. It will be observed that the feeder cables have all the same carrying capacity, notwithstanding the fact that some are nearly twice the length of others. The object of this is to economize conduit space and cost of cables by using the largest cable that can be conveniently pulled through a duct. Provision is made at the plant for keeping the pressure at the ends of all these feeders approximately equal, regardless of their length and the variation in drop, by running different voltages at the switchboard.

Each of these feeder cables connects to a single-pole double-throw switch on the switchboard without the introduction of any fuses or circuit breakers. Each feeder goes through two feeder testing boxes placed at convenient distances along its length, and at the end connects to the system of mains through copper fuses located in the junction boxes.

The mains are composed of three conductors, each of the same size, to provide for better distribution of pressure. The rubber tape surrounding each conductor was made of a distinguishing color for convenience in connecting, and very few errors of this kind were made in connecting together the entire system. At several points junction boxes were placed, which are shown in detail in Fig. 7, into which these three-conductor mains were run and connected to bus bars through copper fuses. These fuses are each provided with a small porcelain knob for convenience and safety in handling while fusing up or disconnecting. The lead sheaths on the mains were divided and brought up through the bottom of the junction boxes and sealed water-tight by means of special stuffing boxes. The lead joint at the point of division outside the box was wiped water-tight. The cover of the junction box is screwed tight upon a rubber gasket by toggle bolts, making a thoroughly water-tight box.

The lateral service cables connecting from the underground mains to the basement of the customers' buildings are similar in design to the three-conductor mains, differing only in size and corresponding variation in thickness of rubber and lead. They are joined to the mains in the service boxes by means of a three-conductor soldered joint, which is carefully insulated with rubber, thoroughly taped and protected by a cast-iron box. This box is then filled with an osokerite compound, thoroughly insulating and preserving the joint from all contact with moisture or other deteriorating substance. The

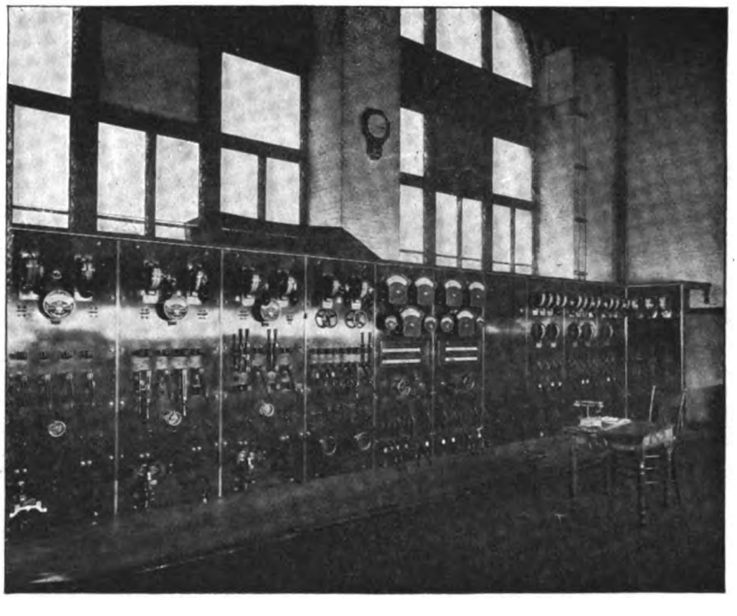


FIG. 6.—SWITCHBOARD.

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insulation resistances of these cables were guaranteed as follows:

No. 16 B. & S. three-conductor, 1000 megohms per mile.
No. 0, 2-0 and 250,000-c. m. three-conductor, 750 megohms per mile.
500,000-c. m. single conductor, 500 megohms per mile.
1,500,000-c. m. single conductor, 400 megohms per mile.

For a break-down test the entire system was submitted to 3000 volts alternating current, and found to withstand this test satisfactorily. The insulation guarantees were also found satisfactory under accurate tests.

The insulation resistances were all measured by means of the capillary electrometer designed by H. C. Burgess, of the University of Wisconsin and described by him at the Omaha meeting of the A. I. E. E. The results were found to be highly satisfactory. It is an extremely sensitive instrument, but is unaffected by magnetic influences or by the jarring of building. The voltage used throughout most of the tests was 100 volts, obtained from a chloride of silver battery. Attempts were made to use a dynamo current from the local power circuits, thus making the test at 500 volts the maximum pressure intended to be carried in use. The attempt was a failure, due to the unsteadiness of the local power circuit and the consequent disturbance due to condenser effect in the cables.

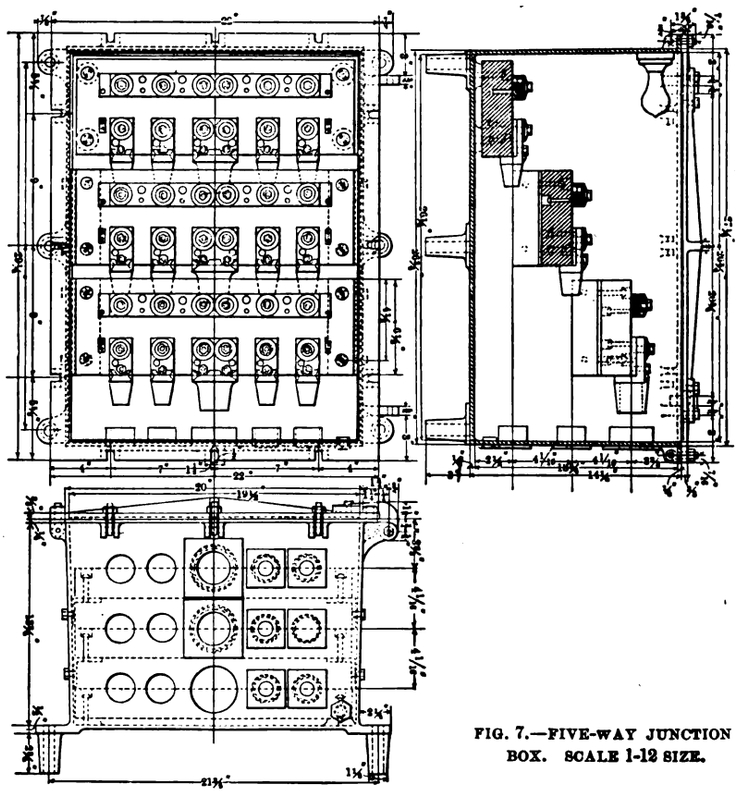


FIG. 7.—FIVE-WAY JUNCTION BOX. SCALE 1-12 SIZE.

### INSIDE WIRING.

The entire inside wiring is done on the two-wire multiple-arc plan. The lateral cables entering the basements of the customers' buildings are three-conductor cables, furnishing either 235 or 470 volts. All electric power service is connected to 470 volts, and the inside wiring is run open and supported on porcelain knobs, with rubber-covered wire. The incandescent and arc lamp wiring is taken off one or the other side of the system at 235 volts and run with rubber-covered wire either on porcelain knobs or cleats or concealed in an approved conduit system. All of the old-style 110-volt cut-outs were replaced. Specially designed tablet boards with terminals properly spaced for the higher voltages, and with inclosed fuses, were used throughout this work. All of the old sockets were replaced with the latest design in porcelain sockets, and where defective cord was observed it was replaced by an approved rubber-covered flexible cord. All of the inside wiring having been gone over in this way, and cleared of grounds and brought up to the latest standard of practice, has resulted in decreasing, rather than increasing, the fire risk following the introduction of the higher voltage system.

### INCANDESCENT LAMPS.

The incandescent lamps used on this system are of the 235-volt type, mostly of 16 c. p. are in use; also small candle power decorative series lamps. The lamps are all Westinghouse cap and porcelain base. The filaments are either double, two in series, or coiled in several convolutions. This characteristic is due to the extra length necessary on a lamp of this voltage. The lamps were bought under guarantees regarding efficiency, life and the maintenance of candle power, which were entirely satisfactory to the purchaser. In practical operation the light has been entirely satisfactory to customers, and they compliment the character of incandescent service furnished. There were at first minor mechanical and electrical defects, however, such as the sagging of the filament until it touches the glass where lamps are not placed in a vertical position, and the short-circuiting of leading-in wires when a filament burns out near its support, all of which have been remedied in later lamps. There have, however, been no accidents or fires resulting from these causes.

### ARC LAMPS.

In the original design of this plant, begun fully three years ago, it was anticipated that its principal business would be power service, and that arc lighting would not exceed 15 per cent of the total service. The introduction, however, of the inclosed arc lamp and its remarkable popularity, due to the steadiness of the light and the facility with which its service is metered, has so increased the demand for arc lighting that the arc service is at present a very important part of the company's business. It was believed at the time that the plant was designed that arc lighting might be made secondary to both the incandescent and motor work. The 235-volt inclosed arc lamp was therefore adopted on account of its convenience, one light being controlled independent of all others. It has been found by experience that two arc lamps burning in series on 235 volts give better service than the single lamp. In cases where a single lamp must be used a satisfactory light has been obtained by increasing the current to 3½ amperes.

### MOTOR SERVICE.

The entire power service is taken from the outside wires of the system at 470 volts. These wires inside of the building in all cases are treated as high-tension circuits. It might be surmised that complaint would be made regarding the power service on account of this reduction of voltage on 500-volt motors. This has not proved to be the case. The motors having been previously used upon systems varying in voltage from 450 to 550, the users of power were educated to expect a considerable variation in the speed of their motors. With a steady pressure of 470 volts at the motor terminals, none of the company's customers have complained regarding their power service.

### LOAD CURVE.

The load curve shows one of the great advantages of the storage battery. The entire plant is shut down from one o'clock until five in the morning, and the load carried upon the battery. The machinery is then started and the battery charged during the forenoon, allowed to float upon the system during the afternoon and discharged during the peak in the evening; and again charged considerably during the first half of the night before shutting down. Interesting features are the large all-night load and the comparatively low peak or maximum load. The average output for twenty-four hours is 2198 amperes, which is 39.27 per cent of the maximum load.

### SPECIAL FEATURES.

The distinguishing features of this plant which marked it as advanced engineering practice are:

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First. The 220-440-volt system of distribution.

Second. The entire system is underground.

Third. The battery equalizer and auxiliary.

Fourth. All subsidiary apparatus is electrically driven.

Fifth. Fuel economizers with induced mechanical draft.

Sixth. Condensing apparatus with cooling tower.

(a) The wisdom of selecting the double voltage system will be appreciated when it is stated that the saving in copper alone in the district covered by this plant is equal to half the cost of the building and entire station equipment. This system was almost unknown at the time of its adoption here, but several plants using it have since then begun operations in Europe, and another large installation is being erected in this country. The system is reliable, safe and satisfactory in its service to the public.

(b) The undergrounding of all wires is the ideal method of distribution as regards public safety, reliability of service and low depreciation and repairs.

(c) The value of a storage battery as an equalizer of pressure and as an auxiliary to the steam plant is universally admitted. It has proved indispensable on many occasions in this plant. Its readiness to take all burdens thrown upon it, whether accident to plant, short circuit in underground cables or sudden demand for light caused by a thunder storm, needs only to be experienced to be appreciated.

(d) Driving all boiler feed, circulating and air pumps, elevator, fans, etc., by electric motors saves the condensation in all subsidiary steam pipes, as well as avoids the wasteful use of steam incident to this class of apparatus. By using steam only in the large cylinders of the condensing engines and driving all minor apparatus by motors, it is estimated that a saving of about 10 per cent. on the entire output of the plant is utilized.

(e) Fuel economizers give all the water entering the boilers an additional temperature of 100 degrees F., which effects a saving of about 9 per cent. in the use of fuel. With coal at $1.50 per ton, they will earn annually about 25 per cent. on their cost.

(f) With losses deducted, it appears that condensing apparatus as here employed make a saving of from 15 to 20 per cent. in fuel, thus earning a large return on its cost.

The entire station equipment was included in one contract, under rigid guarantees from the contractor covering the efficiency of the plant as a whole. A definite cost of coal per kilowatt hour delivered to outside circuits from the switchboard was guaranteed under a forfeiture in case of failure, with an equal bonus for increased efficiency above the figure specified. It was intended to give in this paper the results of these tests, but, as they are not completed, no report can as yet be made.

## THE DESIGN OF FUSIBLE CUT-OUTS.

BY BENJ. H. GLOVER.

Speaking from the standpoint of the fire underwriter, the proper design of cut-outs is an important subject, inasmuch as a very considerable fire waste has been, and continues to be, occasioned through the faulty construction and design of these fittings. All tests and treatments have shown the common cut-out to be subject to such variations and modifying influences that but little of practical value can be deduced from analytical investigations.

In the earlier days of electric lighting, wooden bases were used, but were soon abandoned, due to continual trouble with "grounds" and "shorts" resulting from absorption of moisture and the loosening of contacts, and charring, due to the combustibility of the wood. Porcelain is now almost universally used. The base and cover being much the larger portion of a cut-out, the porcelain manufacturer has taken it upon himself to design and sell these goods. Important electrical details are often sacrificed for convenience in getting out the porcelain, and "any old thing will go" seems to be the motto followed in some cases, no regard being paid to the various and excessive demands made upon the product.

The subject of glazed and unglazed porcelain in itself opens up a large field for discussion. A glaze with an excessive coefficient of expansion will in time become full of cracks or become "crazed," as the porcelain manufacturers express it. These cracks retain moisture and offer paths of comparatively low resistance between terminals of opposite polarity or to ground. The use of lead in the glaze usually results in a metallic film upon the blowing of a fuse. The parts of a cut-out about the fuse itself should preferably be left unglazed. The fuse should not be in contact with any surface of the base. If supports between the terminals are necessary they should be in the form of transverse ribs with smooth rounded tops.

While an air space is desirable about the fuse the ends of the block should not be left entirely open. As a fuse usually ruptures at or near the center the aim should be to provide a proper vent at this point and still retain sufficient pressure to cause a blow-out of the metallic vapors and suppression of the arc formed. For these reasons a rather restricted air space at the ends and an enlarged air chamber with vents near the center of the fuse give more reliable action. A cover for the base should always be used. The fire risk is made less and the sensitiveness of the fuse is increased especially for small sizes.

The Terminals.—Terminals are universally made of brass in the form of stampings, castings or sections of square or round bar. The following modes of connection to the wires have been noted: a screw; a screw and washer; a screw with one upturned lug on terminal, with and without washers; a set screw; two set screws; an angular bottom piece with a clip above held by one or two screws; double clips with a center V groove, and several others.

In the construction of switches it is considered quite proper and necessary to provide lugs, firmly bolted or screwed to the switch, into which the conducting wires shall be soldered. This applies to switches of over 25 amperes capacity. If this is necessary for switches and bus bars and in making connections to dynamos and motors, why is it not so for cut-outs?

Connections for currents up to 25 amperes should be made to terminals provided with screws and washers with a turned up lug on both sides to prevent the wire from slipping out. When the capacity of the cut-out exceeds 25 amperes connections should be made with lugs, firmly screwed to the terminals on a flat surface, and into which the conducting wires can be soldered. This may seem like excessive care, but when it is considered that very appreciable losses are due to the many poor contacts and connections made in a circuit, too much attention cannot be given to this matter of contacts. The terminals should be set in from the ends of the blocks so that live portions of the circuit will not be exposed.

The proper distance between terminals has long been a disputed question. A catalogue of a well-known manufacturer of these goods shows for 110-volt circuits break distances of from ¼ inch to 2½ inches. He no doubt strikes the correct length somewhere. An engineer of a prominent company stated two years ago, "We are redesigning our link cut-outs so that the fuse metal tips shall be fully 1 inch apart. Some of our cut-outs are much less than this, and we believe it is safer to have a longer break distance than what we are now using." A well-known Chicago engineer said a few years ago, "I have always felt that the emphasis of experimental evidence should be directed to convincing the people of the advisability of using long fuse blocks, thereby contributing to the reliability of such protecting devices."

There are many goods on the market with a ½-inch break distance between terminals. A current of 20 amperes will invariably establish a vicious arc between terminals at this distance, and the terminals will frequently melt with explosive violence. The terminals are not only fused but often the entire base and cover are shattered into fragments. Such results are aggravated by the enormous capacity of our modern central stations in populated districts.

For a given fuse, blown in a given time, there is a critical length. Careful experiments have shown that these lengths are as follows:

| | | | |
|---|---|---|---|
| For 3- 5 amperes | . | . | 2½ inches. |
| 10-15 " | . | . | 3½ " |
| 20 " | . | . | 4 " |

Or for each 5 amperes an increase in length of one-half inch.

These lengths seem excessive when

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judged by common practice, but the data clearly indicates where practice might be improved.

Realizing that extended reforms cannot be instituted at once, the rules of the National Electrical Code specify one and one-quarter inch break distance between terminals for 110 volts, and 2½ inches for 220 volts. The fuses to be held free from contact with the base and be provided with tips of hard metal. In the open type of cut-out, the terminals usually have a greater distance between them than in the covered style, but a serious fault in their design is that the terminals are set in flush with the surface of the porcelain. Terminals should be secured to the base by at least two screws so as to prevent turning and loosening. Screw heads on the back should be countersunk and the heads covered with a moisture-proof and insulating wax or compound. These points should go without saying, but an inspection of stock being sold shows that there is neglect along these lines.

The Fuse.—The ordinary fuse is made from an alloy the greater part of which is lead. This alloy is used in the form of wire, wire links or strips. The opening of the circuit is caused by the melting of the fuse. The necessary heat is obtained from the energy developed in the fuse by the current. But the blowing of a fuse is not immediately an electrical act. The current fuses the metal, the cross section is reduced at some point due to gravity, unequal expansion or "sweating," the heat intensifies at this point and a globule falls, breaking the circuit and establishing an arc, which soon burns out a length of the fuse. The time required for this action may vary between considerable limits under different conditions. In some cases this fact is an advantage, while in others it might be fatal.

A combination intended to increase the accuracy of operation and to reduce to a minimum the radiation and conduction of heat is found in the enclosed fuse.

A fibre tube is filled with a porous powder and the fuse is soldered to the brass ends of the tube, being embedded in the powder except in the center of the tube where a small capsule forms an air chamber. These fuses will operate at a predetermined point for any overload and can be relied upon within very close limits. An objection has been made to their use as there is no exterior indication to show when a fuse has opened.

A new design is about to be put on the market with the object of overcoming this objection. It consists of an enclosed fuse with a shunt of fine high-resistance wire between the terminal on the outside of the fibre tube. The blowing of the fuse diverts the current through the shunt wire, which immediately blows and serves as an outside indicator.

For sudden heavy overloads a multiple fuse of several small wires is much more sensitive than the one large one of the same capacity. For the same reason a thin, flat ribbon may be considered more reliable than a round fuse.

# Among our Foreign Contemporaries

**A Means of Paralleling Alternators.**—In throwing one alternating-current machine in parallel with another difficulties are always found in getting the two to run at exactly the same speed. If their governors are properly adjusted to each other they will run at the same speed when both are loaded, but if one is loaded and the other is light the loaded machine will be running at a slightly lower speed than the other. To throw in a fresh machine in parallel with others loaded the fresh machine must be slowed down in some way to the speed of the others. In the early days of parallel working this was done in foreign plants by putting an artificial load

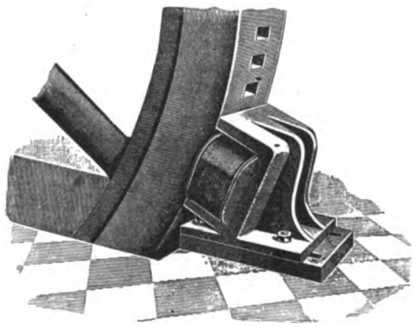


FIG. 1.—A BRAKE FOR USE IN COUPLING ALTERNATORS.

of lamps upon the fresh machine. It was then thrown in parallel with the others, after which the artificial load was cut out. In this country the speed is commonly lowered by throttling at the main stop valve, or the governor is fitted with an arrangement for temporarily reducing the speed at which it will tend to run the engine. An artificial load somewhat less crude than the big bank of lamps is used to a certain extent in Germany, and was described in a recent paper by G. Dettmar in the "Elektrotechnische Zeitschrift." The load consists simply of a magnet facing the rim of the fly wheel, as shown in Fig. 1. By exciting this magnet very powerful foucault currents are set up in the rapidly revolving fly wheel rim, absorbing sufficient power to slow down the engine to synchronism with the other engines loaded. The machine is then thrown in and the magnet de-energized, relieving the fresh machine of its artificial load and allowing it to pick up its share of the useful load. The artificial load of course generates considerable heat, but this is distributed throughout the fly wheel rim so that in the short time during which it is in use there is no great rise of temperature.

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**High-Pressure Low Candle-Power Lamps.**—In a letter to "The Electrician," London, Mr. Alfred H. Gibbings, Electrical Engineer to the City of Bradford, makes the following statements: "I may say that, owing to our free supply of incandescent lamps for renewals, which amounted to over 9,000 last year, we have been led to look carefully into the respective merits of almost every incandescent lamp which is imported into this country. We have tested about 30 different makes, both for life, uniformity of candle power and efficiency, and there can be no question that at the present time the majority of manufacturers make equally as good if not better 200-230-volt lamps for all candle powers that was the case when 110-115 volts was the standard voltage." The same is very far from true of lamps made in this country, and the conclusion is inevitable that, compared with American standards, either the high-tension lamps imported into England are very good or low-tension lamps were very poor.

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**A Novel Means of Fastening Conductors on Smooth-Body Armatures.**—In an article on "Low Voltage Dynamos," contributed to "The Electrician" of London, Mr. E. K. Scott argues in favor of machines in which the commutator bars form part of the armature windings as they do in the Siemens & Halske outside armature type. For electro-metallurgical machines which are liable to short circuit it is important to keep the field relatively strong, and this is best secured by having a smooth body armature and a long air gap. At the same time it is important that the bars should be held very securely on account of their having to take suddenly varying tangential pulls. On the machines for the Falls of Foyers the Oerlikon Works have adopted the detail of construction shown in Fig. 2. As this indicates, brass plates ⅛ in. in thickness are interspersed be-

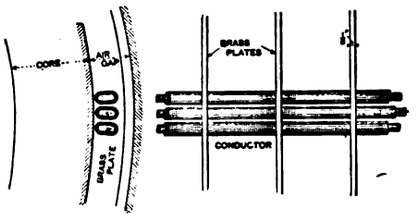



FIG. 2.—A MEANS OF FASTENING CONDUCTORS ON SMOOTH-BODY ALTERNATORS.

tween the armature laminae at intervals. These brass plates go in as far as the spider and extend out beyond the laminae and almost to the pole pieces; holes are punched in the plates just large enough to take the micanite tubes surrounding the conductors. In this way a long air gap is obtained, and yet each conductor is positively driven just as well as in toothed armatures.

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**An English Safety Valve.**—In English boiler practice the spring actuated "pop" safety valve is comparatively rarely, if ever, found, their safety valves being as a rule loaded by dead weights and not capable of being locked against overloading as are American types. The English valves are also made to respond to either high or low water level in an ingenious way, which is illustrated in Fig. 3, reproduced from "The Practical Engineer." Here the valve is of the closed type fitted with a flanged opening for connection to an exhaust outside the building. The valve disc is an inverted cup closing against the seat shown at S. The upper end of this cup rises through a bearing in the enclosing case and supports a heavy inverted cup-shaped casting, C, on which may be placed any desired number of ring-shaped weights, W, the number of weights being varied according to the working pressure of the boiler. The valve disc is guided by the bearing in the case by lugs, which the illustration shows immediately outside of the valve seat. The response to high and low water is obtained by means of the floats shown below in the boiler. These are connected with a lever which operates a rod passing up within the cup of the valve. In case the water level falls below the normal position of the low-water float or above the position of the high-water float, this rod is pushed up until a nut upon it lifts the valve off its seat and allows the steam to escape. An extension of the same rod apparently operates the valve of a whistle mounted on top of the safety valve, this whistle giving notice of the abnormal condition of the water level before this condition becomes so extreme as to raise the safety valve.

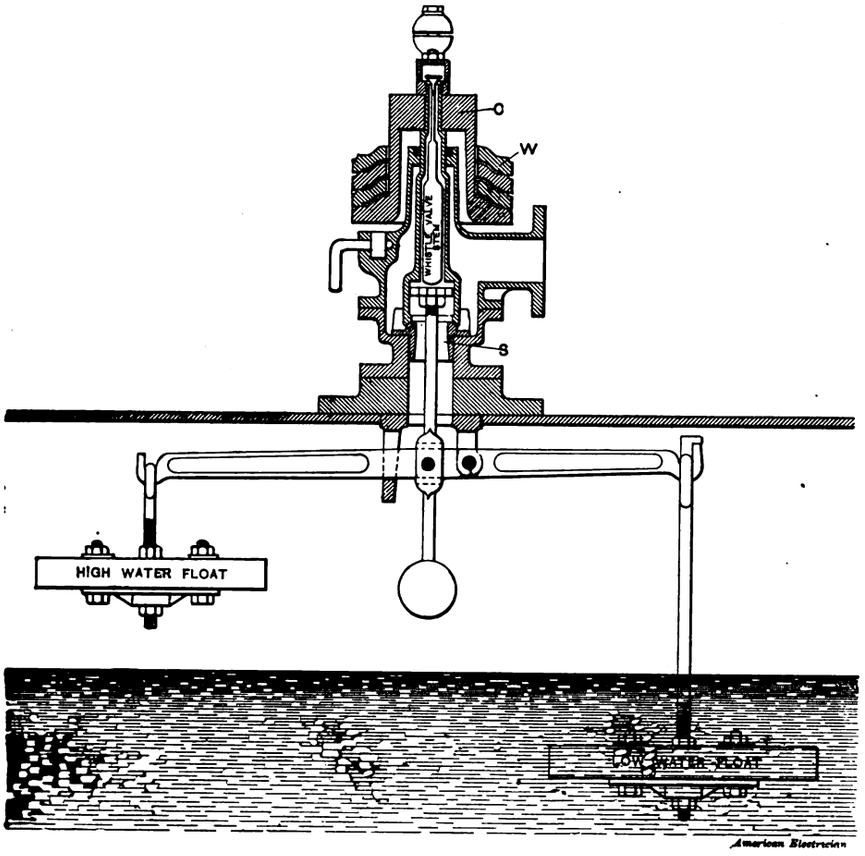



FIG. 3.—A HIGH OR LOW WATER SAFETY VALVE.

**An Electrolytic Method of Sharpening Files.**—Mr. Sherard Cowper-Coles contributes a note on this subject to the "Electrical Review," London. The cutting edges of a file can be readily sharpened by dissolving off a thin and even film of the steel. Among experiments which were made for the purpose of determining the best conditions, current densities were tried varying from one to 500 amperes per square foot, and a large number of electrolytes were tested. The best results were obtained with a solution of ferric chloride and high-current densities, averaging about 500 amperes per square foot, and applied for 15 minutes.

**Another Possible Electric Lamp** —In a paper recently read by Mr. A. A. Campbell Swinton before the Philosophical Society of Glasgow an experiment was described in which a light of several hundred candle power was obtained with less than one watt per candle and at a very high pressure, 8000 volts. The light was obtained from cathode rays which are the bombardment of the highly attenuated particles of matter in a highly exhausted tube. These rays were concentrated at one point, setting up there an extremely high temperature comparable with that of the electric arc. By using a disc of thoria, one of the emissive substances used in Welsbach mantles, the high temperature obtained gave a highly efficient light.

**A Novel Method of Transporting Freight on Electric Railways.**—The Bessbrook & Newry Electric Railway in Ireland handles ordinary wagons, which, when they leave the electric line are drawn, as usual, by horses. The wagons are not transported on trucks or flat cars, but are simply run on a track of flat rails placed immediately outside the regular tee rails for the cars. The gage of the cars is such that the tee rails serve as a guide to the wagon wheels. The system allows freight to be transported without rehandling or without terminal charges and with comparatively little delay at the transfer points.

**Large Steam Turbines.**—The largest steam turbines in the world are two of some 1400 h. p. capacity each, being built by the English firm of C. A. Parsons & Company for a municipal lighting plant in Elberfeld, Germany. The machines are of the standard Parsons type and are coupled directly to four-pole alternators designed to give 250 amperes at 4000 volts or 1000 kw. The speed is 1500 r. p. m., giving a frequency of 50 cycles per second.

**Losses at Brushes in Testing Dynamos.**—In a long discussion on the question of testing dynamos and determining the various losses, in the German journal, the "Elektrotechnische Zeitschrift," Mr. Fischer-Hinnen contributes some matters of interest, and as he has had considerable experience in the construction of dynamos his conclusions can no doubt be accepted as good practice. He also confirms the statement about which there has been some discussion recently, namely, that the friction losses in a machine at a constant speed increase with the excitation, and quite appreciably so; this is of importance in certain methods of testing dynamos for their efficiency. He attributes this to the attraction of the armature by the magnets, due to the fact that the armature may be slightly eccentric. The effect of this side pull is specially great when the machine is started, and the frictional coefficient in that case may be from 8 to 10 times that at normal speed, a matter which may be of importance in connection with traction motors. Incidentally he states that the losses due to hysteresis and Foucault currents increase quite appreciably with the load on the machine. Concerning the losses at the brushes he gives some simple formulas and data; these losses, even in approximate determinations of the efficiencies, are not to be neglected. With the usual machines of 100 to 125 volts, the losses are approximately as follows: For metallic brushes the losses due to the Joule effect (that is, the loss which is

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equal to the square of the current multiplied by the resistance), are from 0.4 to 1.2%, and those due to friction, from 0.2 to 0.5%; with carbon brushes these figures are 1 to 2% and 0.5 to 1% respectively. The total loss will be least when that due to the Joule effect is equal to the friction loss, both, of course, being given in the same terms. For the cross section of the brush in this case, in which the total loss is a minimum, he gives the following formula

$$S = \frac{0.21}{\sqrt{v}} \frac{C}{p}$$

for metallic brushes, in which S is the cross-section in square centimeters, v the surface speed of the commutator in meters per second, C the total armature current, and p half the number of circuits in parallel; in an ordinary armature in which there are two such circuits the value of p would simply be unity. For carbon brushes the formula is the same except that the value of the constant is 0.68. For the minimum total loss at the brushes in watts he gives the following formula

$$W = 0.39\ C\sqrt{v}$$

for metal brushes; for carbon brushes the formula is the same except the constant is 1.19. For medium large machines of 20 to 60 kw. at about 100 volts, having two to four brushes, it is not always easy to give the brushes the cross-section required by the above formula, and in that case the loss will be greater than that given in the second formula. For a surface speed of 8 meters per second the total loss due to the brushes will be greater than 0.8 to 1% for metallic brushes, or for carbon brushes greater than 2.5 to 3%.

# Some Recent Electrical Patents.

**A Laminated Pole Dynamo.**—In most dynamo-electric machines with laminated poles it is customary to make at least the field yoke ring solid, the polar laminations being either cast into the yoke ring or bolted to it with a finished joint. Mr. Robert Lundell describes a machine in which the whole field is constituted of C-shaped iron or steel laminations. One of these is shown separately in the small view at the right hand side of the accompanying cut, the method of assembling them being shown in the larger view which is an end elevation of the machine. The ends of these stampings or laminations, which project inwardly toward the armature and constitute the poles, are surrounded as usual by the field coils, and between the laminations

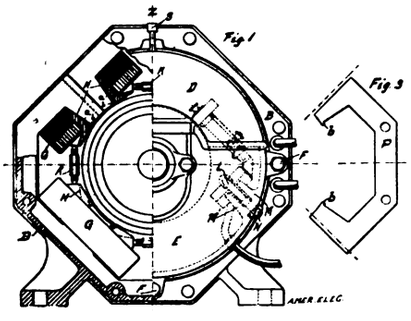


FIG. 1.—A LAMINATED POLE DYNAMO.

and the coils are cast-iron polar extensions H, which serve a triple purpose of holding the laminations together, of retaining the coils in place and of providing pole horns of a permeability lower than that of the pole center and thereby giving a commutating field through a material saturated at no distortion and therefore not seriously affected by a distorting tendency. These polar extensions are caught by catches b projecting into notches a and are further held by jack-screws K. Patent No. 626,496.

**A Compound Telephone Circuit.**—A good illustration of the available multiplicity of combinations of telephone apparatus is the patent issued to T. C. Burgess and H. W. Wilder, describing a means of making one telephone responsive to either of two others which are not in communication with each other. The combination is designed for exchange operators whose head sets should be in an order wire or instruction circuit and yet who should be able to cut in to subscribers' circuits when they so desire. The design is such that the order wire connection remains in the operator's head set but no conversation can cross from the order wire to the subscriber's circuit. The elements of the circuit are shown in the accompanying diagram, in which the apparatus at the right hand side is the operator's telephone, and t represents a microphone supplied by the battery, b, through the primary q, of the induction coil I. The secondary of this induction coil is divided into two equal sections,

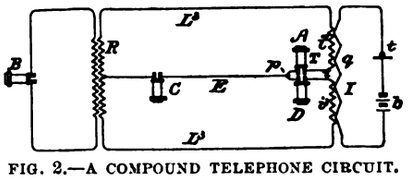


FIG. 2.—A COMPOUND TELEPHONE CIRCUIT.

$i^2$ and $i^2$, connected in series with each other through the receiving telephone, T, and the coil, D, which has an impedance equal to that of T. In the left hand side of the figure, B represents the subscriber's instrument, connected with a repeating coil, R, for transmission to the operator's set over the lines, $L^2L^2$. Connected between the point, p, and the middle of this induction coil, R, is another line, E, containing the telephone apparatus, C, which may be an order wire or instruction circuit. C can then telephone to T, but owing to the fact that its currents split and go in opposite directions through the two halves of the repeating coil, R, such conversation has no effect upon B, nor is B able to talk to C. T, however, can hear either B or C and can talk to the former. By various other arrangements of the parts different possibilities can be provided for. Patent No. 626,826.

**A Brush Holder of the Reaction Type.**—During the last two or three years various modified forms of the simple style of brush holders, known as the reaction type—originally designed and claimed in patent No. 504,901 by Mr. R. N. Baylis—have been adopted by many if not a majority of the manufacturers of direct-current dynamos and motors in this country. Among the companies adopting this type of brush holder is the Bullock Electric Manufacturing Company, three of whose engineers, Messrs. W. Cooper, W. H. Warren and C. A. Mudge, have recently obtained a patent on the combination of details of an improved form of holder of this type. A section of this improved form is shown in Fig. 3, in which A is a commutator, B a carbon brush forced against the commutator and the conducting plate of the holder by the curved arm, C, held in place by the spring, E. This spring is attached to the thumb hook, P, provided with a pin which engages in notches, p, by means of which the effective leverage of the spring and the pressure on the brush holder may be varied. This gives a remarkably simple construction and one which can be almost instantly dismantled and reassembled, as by simply pulling the hook, P, away from the arm, C, the latter

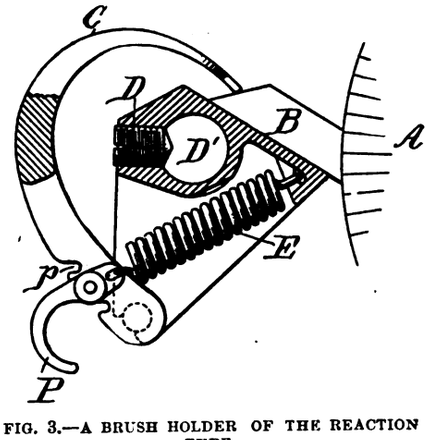


FIG. 3.—A BRUSH HOLDER OF THE REACTION TYPE.

can be taken out from the holder. Patent No. 634,804.

**A Time Element Attachment for Circuit Breakers.**—One of the inherent faults of the ordinary circuit breaker for motor protection is its instantaneous operation with any brief overload which does no particular harm to any part of the circuit. A motor will readily stand a considerable overload for a short time as in starting up, and should be made of such a size as to be occasionally overloaded so

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that its average load may be at or near its point of maximum efficiency. If protected by a circuit breaker the latter will be always coming out when a brief overload exists unless adjusted to carry such an overload, in which case the motor will be burned out if the overload is continued. What is needed is a circuit breaker which will operate instantaneously in case of a violent overload or short circuit and will be sluggish or slow upon a small overload, only opening it if the condition continues. Mr. W. M. Scott has patented an attachment for this purpose to be applied to the I. T. E. circuit breakers.

The general arrangement of the parts is shown in the accompanying figure from which it may be seen that the device possesses considerable complexity. Its operation in brief is as follows: The two vertical solenoids are connected with contacts made and broken by the armature between them in such a way that the apparatus acts as a vibrator, moving the central lever up and down. A pawl, 24,

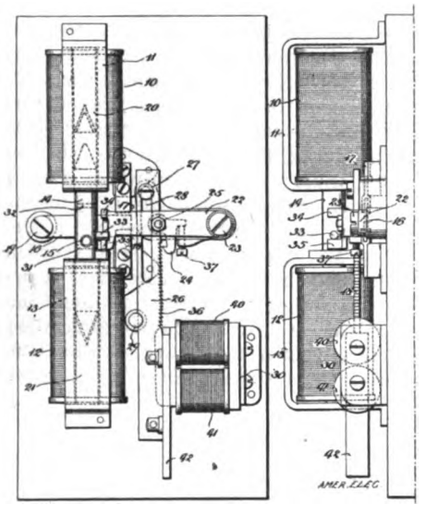


FIG. 4.—A TIME ELEMENT ATTACHMENT FOR CIRCUIT BREAKERS.

upon this lever engages the teeth of a ratchet, 26, gradually hitching the latter up, the magnet, 40, serving as a lock or catch to prevent it from falling when the pawl, 24, moves downward. When it is moved up a certain distance it closes across the mains the circuit of an auxiliary winding around the plunger of the circuit breaker proper, causing the latter to be operated in the customary way. The auxiliary apparatus shown in the figure is operated by shunt currents sent to it by an auxiliary contact on the circuit breaker proper. This auxiliary contact is worked by the regular movable plunger or core when it rises with a feeble force due to a slight overload. If this slight overload continues the ratchet is gradually worked up to the top limit, and the auxiliary coil is thrown into circuit and the breaker operated. If the slight overload ceases before the ratchet gets to the top the current is removed from the various coils shown in the figure, and the ratchet falls to its lowest position. If the overload is violent the main plunger of the circuit breaker lifts the auxiliary contact and operates the trigger directly, as usual. In spite of the complexity of the apparatus and the many other possible simpler ways of accomplishing the same purpose, the claims are very broad, the first claim covering practically the combinations of an automatic magnetic circuit breaker with an auxiliary coil closed by magnetic means in case of an overload. Patent No. 624,895.

**Electric Meter Protection.**—The shunt or potential circuits of electric meters are customarily connected on three-wire systems between one outer conductor and the neutral. If the meter is between the fuses and the lamps and the fuse is removed from the outside wire to which the meter shunt connects (let us say that this is the positive wire), then there will be voltage on the meter shunt and lights can be burned between the neutral and the negative without registering on the meter. It sometimes happens that unscrupulous consumers knowing of this will remove the fuse and thus throw the meter out of operation, getting their lights on the negative side of the system free. Mr. Eustace Oxley has patented an arrangement for overcoming this objection, which consists simply in a high-resistance shunt around the fuse. It is difficult to see how this arrangement can accomplish its purpose, since a few lamps turned on on the positive side would give a drop of practically the whole voltage in the high-resistance shunt so that the potential winding of the meter would not get any pressure even in this case. The best remedy appears to be to put the meter on the central-station side of the fuses. Patent No. 632,739.

## NOTES.

**The Underground Rapid Transit Railroad in New York City at Last Gives Promise of Actual Construction.**—The commission has advertised for proposals for constructing, equipping and operating the lines with the idea of awarding a contract within thirty days if a satisfactory bid is received before January 15, 1900.

**A Notable Hydraulic Power Plant Burned**—The power house of the Standard Electric Company at Blue Lakes City, California, was destroyed by fire on the morning of November 1st. The plant contained three 450-kw. Stanley two-phase inductor type machines feeding high-tension lines running to neighboring cities and Stockton.

**The Proposed Use of Automobile Omnibuses in New York City.**—It is stated that the New York Electric Vehicle Transportation Company, the local representative of the Electric Vehicle Syndicate, has acquired the property of the Fifth Avenue Stage Company, New York City, and will equip this famous line with electrical omnibuses as soon as they can be built. Orders are said to have been placed for a number of the vehicles, which are being constructed at the works of the Columbia and Electric Vehicle Company at Hartford.

**New High-Speed Telegraph Experiments in This Country.**—Messrs. Anton Pollak and Joseph Virag, Hungarian inventors of the high-speed system of telegraphy using a photographic receiver, recently described in these columns, have arrived in this country to conduct experiments on American telegraph lines. The system has been tested under the supervision of the Guardian Trust Company of Chicago. Speeds of about 150,000 words per hour have been obtained on short lines.

**A Tunnel for Telephone Cables.** — The Illinois Telephone & Telegraph Company, a new independent concern, is now building a tunnel in Chicago to extend from Fullerton Avenue on the North Side, south to 55th Street, with a branch westward to Western Avenue. It will be 4 feet wide and 7 feet high, lined with concrete, and will be fitted with racks for the wires and cables. The crown is about 30 feet below the street level, so as to avoid interference with sewers and pipes.

**The Sale of Power at Shawinigan Falls.**—The Shawinigan Water & Power Company, which is now developing the water power at Shawinigan Falls, Province of Quebec, is reported to have sold to the Pittsburgh Reduction Company the right to use 10,000 h. p. and to the Shawinigan Carbide Company the right to a similar amount. These companies will take the power in hydraulic form and develop it in their own generating plants. The Shawinigan Company itself is also reported to have awarded a contract to the I. P. Morris Company for a pair of turbines capable of developing 6000 h. p., or larger than those at Niagara. The Pittsburgh Reduction Company has let contracts to R. D. Wood & Company and the Westinghouse Electric & Manufacturing Company for wheels and generators, respectively, capable of developing 6000 h. p.

**An Anti-Bell Telephone Merger.**—The Telephone, Telegraph & Cable Company of America, with an authorized capital of $30,000,000, has filed articles of incorporation. The company is understood to be financed by Mr. Martin Maloney of the famous Whitney syndicate, which has already obtained extensive holdings of electric light and traction properties in the large cities. Its avowed purpose is to establish long-distance telephone lines, bringing together the various independent concerns and systems, particularly in the large cities. The hold already obtained by interests associated with the new company on conduit rights in the large cities, particularly New York, would give the company a powerful means of advancing its ends, and has given rise

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to surmises and rumors that even the Bell monopoly may be outdone in its own field.

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**A Portable Lighting Plant for Fire Department Use.**—A novel addition is soon to be made to the equipment of the New York Fire Department in the shape of a complete projecting arc-light outfit on wheels. The machine will resemble a fire engine in general appearance and will use a similar boiler, but in place of the pumping machinery the engine will drive a dynamo which will supply current for the arcs. There will be two of these, each with an 18-inch projecting lens, and these will be carried on a platform behind the driver's seat. They can be used either on the platform or removed and carried to any convenient place near by, their connection with the dynamo being kept up by means of flexible cables. The purpose of the new apparatus will be to light up dark places in the street and aid firemen in laying hose, setting ladders, etc., and also to light up the fronts of the buildings where people may be in danger.

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**Tests of Aluminum Wire for Fire-Alarm Purposes.**—City Electrician E. B. Ellicott of Chicago has instituted practical tests of aluminum wire in Chicago for fire alarm service. The wire will be left up all winter, in a location parallel with railway tracks, where it will be subjected to fumes and smoke from locomotives. One span 225 feet long crosses the tracks; another piece is under test in another part of the city under similar conditions and alongside a new copper wire of the same size, so as to give comparative results. The comparative tests made on copper and aluminum wire before erection gave the following results:

| | Twists in 6 inches. | Breaking weight in pounds. | Elongation in 5 feet (inches). | Weight per mile in pounds. |
|---|---|---|---|---|
| No. 10 hard-drawn copper wire..... | 55 | 515 | 3 4/64 | 173 |
| No. 10 aluminum..... | 27 | 275 | 1⅛ | 51½ |

It is interesting to note that although the copper wire gave greater elongation and number of twists, the breaking weight of the aluminum wire was more than half that of the copper wire of the same size, while the actual weight of the wire was less than one-third.

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**The Exploitation of the Marconi System in this Country.**—The Marconi Wireless Telegraph Company of America was incorporated Nov. 22d with an authorized capital of $10,000,000. The president of the new company is Mr. Isaac L. Rice of electric storage battery interests. Among the other incorporators are Messrs. Guglielmo Marconi, August Belmont and Clement A. Griscom. The company expects, among other business, to equip signal and life saving stations along the coast and manufacture wireless instruments for ships. Since the completion of the International yacht races and previous to his return to Europe, Signor Marconi made tests of the wireless system for the benefit of the U. S. Navy under the auspices of the Naval Board. The report of this board was highly favorable to the new system. Among other decisions the board made the following statements: "When two transmitters were sending at the same time all the receiving wires within range received the impulses from the transmitters. In every case under a great number of varied conditions the attempted interference was complete. Mr. Marconi, although he stated to the board before these attempts were made that he could prevent interference, never explained how nor made any attempt to demonstrate what could be done. Between large ships (heights of masts 130 and 140 feet) and a torpedo boat (height of mast 45 feet), across open water, signals can be read up to 7 miles on the torpedo boat and 85 miles on the ship. When ships are close together (less than 400 yards), adjustments, easily made, of the instruments are necessary. The rapidity is not greater than 12 words per minute with skilled operators."

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**Electric Motor Auxiliaries for the Navy.**—In his last annual report Chief Engineer Melville, of the U. S. Naval Department, explains the hitherto announced decision not to use electric motors generally for auxiliaries in ships now under way or planned. After outlining the well-known advantages, such as the absence of heat, condensation and danger from shot and shell in electric wires, as compared with steam pipes, the report continues as follows: "Against these, however, are to be put the much greater weight of the necessary electric outfit, the greater delicacy of the type of electric motors ordinarily used, the lack of ready adaptability to the various conditions of service, a general denial of the claims for economy as ordinarily presented, and the increase in the amount of space required below the protective deck for the installation of the necessary dynamo rooms, this space being necessarily taken from coal bunkers. . . . On the battleship 'Alabama' the space required for electric motors, where used, is approximately the same as that required for steam engines to do the same work. The space required for the wiring, etc., is less than that necessary for steam piping, had that been used. The space required for the generating sets is 10,140 cu. ft. The capacity of these generating sets is 256 kw. total. If all the auxiliary machinery on board this ship were operated by electricity, and if the space required for the electric generators were increased in the ratio of the increase of necessary capacity in the generating room, the space that would be required in the generating rooms would be 50,700 cu. ft. for a capacity of 1,280 kw. Consequent upon the extension of the use of electricity would be an increase in the total weight of the machinery equal to from 150 to 250 tons as a minimum. This loss in weight is as much as the gain following the use of water-tube boilers. The increased space occupied by the larger generating rooms would accommodate 900 tons of coal, or 3,600 h. p. could be added to the power of the propelling engines, giving the ship in the first instance 45 per cent. greater coal endurance, or in the second instance 1.5 knots increase in speed."

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**High-Speed Service on Private Rights of Way in Buffalo.**—The International Traction Company has recently put in service a new route for the Buffalo & Lockport line. On account of the length of this line, high speed and a private right of way are almost imperative. Between Tonawanda and Lockport the cars always have run on the Erie railroad tracks, but heretofore they have followed the street route of the Niagara Falls line between Tonawanda and Buffalo. The new section consists of a track about six miles long from Tonawanda in to Buffalo city line, where it turns into Main Street near Cold Spring, and thence runs down town. The new private right of way has allowed a considerable reduction of the schedule time, which is now 70 minutes between the downtown section of Buffalo and Lockport, the time on the New York Central road being from 50 to 55 minutes. Of this 70 minutes 30 minutes is spent on the streets of Buffalo, the average speed on the private right of way being about 45 miles per hour between stops, with mixmum speeds running up to nearly 60 miles per hour. The new section of the road is single track, laid with 85-pound American Society standard rail, the whole line being operated by a regular train dispatching system exactly like that of the steam roads. The passenger cars run every 30 minutes throughout nearly the whole day. The new section embodies a slight departure from previous overhead construction designed by Mr. C. K. Marshall. The overhead wire is carried by bracket construction, but instead of suspending the trolley wire immediately from the brackets, a 7/16-inch stranded steel cable is strung the whole length of the line and the trolley wire is hung from this cable by means of ordinary straight-line hangers offset on the cable a considerable distance from the brackets. This gives flexible suspension and in addition prevents any break of the trolley wire from twisting out of shape several brackets. The International Traction Company has also directed the General Electric Company to gear up one of its freight locomotives for experimental purposes, to determine its applicability to passenger train service. The locomotive will be geared to give a maximum speed of 70 miles per hour, and if this speed can be attained with a load of 150 tons, electric locomotives will be adopted on the Erie tracks between Buffalo and Niagara Falls to haul the regular Wabash and other passenger trains.

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### High-Voltage Three-Wire Systems.

There will be found in this issue of the American Electrician descriptions of two central stations operating multi-wire systems of distribution with double the voltage customary on Edison systems. One is a large metropolitan plant supplying an extensive underground district, while the other is in a small place and designed for scattered loads. While three-wire direct-current systems with 400 to 500 volts between the positive and negative conductors have become almost standard practice in England, they are as yet rare in this country and a word or two as to their advantages and disadvantages may be of interest.

The chief disadvantage is of course the poor economy of the high-voltage incandescent lamp. In the present state of the art of lamp making a 16-c.p. 220-volt lamp requires from 60 to 65 watts, while a 16-c.p. 110 to 115-volt lamp of corresponding life, deterioration, etc., requires only 50 watts. To be sure, if current is sold on a kilowatt-hour basis the consumer stands the extra cost, but this handicaps the station—once it is known—competing with other systems or with gas. On this account power for lighting at least should be sold on high-voltage systems at a rate about 20 per cent lower than is quoted by low-voltage stations. Another disadvantage that might carry considerable weight at first is the increased risk due to the high pressures, but as pointed out in the article on the Imperial plant of St. Louis, the modern systems of interior wiring with approved fittings are safer under high voltages than the average work of a few years ago is under ordinary voltages.

The great advantage of the high-voltage is of course the reduced cost of copper and the consequent increased available radius of supply. For a given distribution the necessary amount of copper is of course reduced by doubling the voltage 75 per cent, although the cost of the insulation and the installation of the feeders and mains is not reduced in this proportion and the cost of pole lines or conduits may not be reduced at all. As to increased radius of supply, Mr. Humphrey states in the article on the Imperial plant that "the area which can be supplied from one central station at the same percentage of loss is increased 16 times." This means that the radius of supply is multiplied by four by the adoption of the higher voltage. While this is theoretically the case with the same cross section of feeders and with the same load, it is not commercially the case figured on the basis of the same cost of the distribution system per kilowatt distributed. If the same amount of copper is used for the same percentage drop the radius of supply is only twice as great with the high-voltage system as with the low, and the area of supply is increased four times instead of 16 times. Even then the cost of the distributing system is considerably increased as the copper is but a small fraction of the total cost, and the cost of insulation, lead, conduits, etc., is more a factor of the length than the cross-section of the feeders.

With the constant tendency toward the concentration of the generating system into one central power house the high-voltage three-wire system becomes the only means of distributing power over a city of moderate dimensions by means of direct-current without resorting to substations and a rotary-converter system. A great practical advantage of the high-voltage system in many cases is the possibility of bringing all motors previously operated on 500-volt power circuits on to the lighting service, thus considerably simplifying both the generating machinery and the distribution system.

### Balancing Three-Wire Systems.

It has always been customary in this country to supply three-wire systems from separate generators on the positive and negative sides, each machine delivering half the voltage of the system and being connected between the neutral and one of the outer bus bars. While this practice is commendable and necessary in small installations, it becomes a source of unnecessary multiplication of machines in stations running many generators and a source of no little loss when the generators become of large size. Where the number of generating units becomes large the actual number of dynamos can be cut in two by substituting for the positive and negative machines of each generating unit one dynamo of double the voltage connected between the outer conductors and maintaining the proper mid-potential of the neutral by some other means.

The means most commonly adopted for this purpose in England where full-voltage machines are more common, is the use of two shunt-wound motors mechanically coupled together with their armatures electrically connected in series with each other across the outer mains. If the load upon one side of the system becomes greater than that upon the other, the motor upon the lightly loaded side absorbs electrical power, giving it mechanically to the other machine coupled to it, which acts as a generator delivering the power to the heavily loaded side. In extensive installations where the sizes of the generators become large, 1000 kw. or more, the losses through the double commuta-

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tion, the double equipment of leads from the switchboards and the switches, become quite serious. The use of single machines generating the full voltage of the system materially reduces these losses as well as the first cost of the whole equipment. A large three-wire system is always so nearly balanced that a very small pair of machines, compared with the whole generating equipment, will serve to maintain the balance.

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**Static.**

Whatever limitations of voltage may or may not be found in long-distance transmission on aerial lines, a serious check has been found wherever the transmission is compelled to be as a whole or in part via underground cables. This limitation is due to what is commonly called "static." But little seems to be known concerning the cause or origin of this phenomenon, but its effects are universally found wherever an underground cable forms part of a high-tension scheme. It manifests itself as a charge tending to jump to ground with a voltage apparently much higher than that supposed to be in use on the system. If no less resistant path of discharge is provided this static will invariably rise to such a pressure that it will puncture the cable insulation. If a path is provided—a common form consisting of an air gap in series with a high resistance—static will occasionally jump this gap, which can be made much wider than any gap which the nominal voltage of the system would jump. If paths of this kind are not provided the static has an annoying way of creeping and sparking over considerable distances at cable heads and similar locations where it can follow the surface of the insulation from the conductors to ground, gradually eating or burning away the insulation until a complete breakdown follows.

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Exactly what this static is due to does not seem to have been as yet clearly determined, or at least does not seem to be understood by many who are troubled by it. Every high-tension circuit consists of a number of lines, transformer windings and in some cases machine windings all insulated by many megohms resistance from the earth. For some reason this highly insulated system seem to become, when in operation, electrified until sparks jump to ground at the weakest point, no matter how strong the insulation may be. The static may be due to effects of capacity and self-induction piling up charges and high potentials at certain points in the cables; it may be due to selective-leakage, a positive charge passing through the dielectric to ground more easily than a negative, or it may be due to some entirely different cause, but whatever its source, it seems to limit the pressure which can be commercially applied to alternating-current underground systems in the present state of the art to about 10,000 to 12,000 volts. Higher voltages cause frequent break-downs, no matter how thick the insulation may be (not due directly to the electrostatic stresses, but due to the indirect effects of static), so that engineers rarely attempt them.

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What would perhaps prove a simple cure is the grounding of one leg of the system, or, better, of a common neutral point, an arrangement sometimes used abroad. With a direct electrical connection to ground it is difficult to see how the potential of any leg of the system could differ from that of ground by any more than the voltage set up by the generating apparatus. This cure is, however, considered objectionable in this country, as with it the accidental grounding of any conductor would cause a short circuit and consequent interruption of supply. On the extensive high-tension systems now in use in this country grounds are frequent, but in each case are easily removed before another ground occurs on another leg of the system, so that they cause no interruption of service. Another possible remedy that would not be open to this objection is the use of induction or choke coils with an ample cross section of copper connected between the high-tension conductors and ground. These would serve to give an electrical connection which would discharge any abnormally high electrostatic pressures, but in case of a ground on any leg of the system would not act as short circuits.

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**Guarantees.**

The custom of requiring and giving most elaborate and rigid guarantees of the performance of steam and electrical machinery appears to be on the increase. Engine makers bidding for recent contracts must guarantee not only the steam consumption over a considerable range of load, regulation under combined changes of load and steam pressure with or without a vacuum, a large maximum overload capacity, but oftentimes a slight maximum variation from true uniformity of rotation, or some similar difficult requirement. A dynamo maker must guarantee no more than a certain rise in temperature in various parts of the machine under a given load, the ability to carry a very heavy overload without sparking, insulation resistance, regulation, efficiencies at various loads, and oftentimes peculiarly difficult specifications of the purchasing engineer.

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A notable case of stringent guarantees is that of the Imperial plant in St. Louis, some of which guarantees are mentioned in the paper by Mr. Humphrey on other pages of this issue. In addition to the individual guarantees on the separate machines the whole station in this case was covered by one blanket guarantee of the contractor to give a certain efficiency as a whole, a definite cost of coal per kilowatt hour delivered to outside circuits from the switchboard being specified.

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While this practice of requiring guarantees of a highly perfect performance undoubtedly improves the quality of machinery supplied, it often does so at great cost to the consumer. The penalty in the case of failure of all small contracts is the rejection of the apparatus, which compels the manufacturing companies to allow a sufficient margin in the contract price to cover the risk. A dynamo which would be otherwise a highly perfect machine might not be able to carry a 50 per cent overload without slight adjustment of the brushes and without sparking. This may cause the rejection of the machine, although in other qualities, such as heating, etc., it may be quite superior. Indeed, it is often the case that the machine rejected is on the whole better than the machine given in its place, particularly if the quality in which the first machine was deficient requires a sacrifice of some other good feature, as is often the case. Frequently no real adequate test is made as to whether the machine does or does not comply with the guaranteed requirements. This is a particularly unfortunate condition, as it allows unscrupulous bidders to put in poor machinery and run the risk of detection. This is particularly likely to happen in cases where it is difficult to make accurate tests, as for instance, in the case of the efficiency of direct-coupled machines. Perhaps a most conspicuous example of rigid specifications are those of the United States Government. On account of them the Government pays much more for its supplies and equipment than does any private consumer, getting better apparatus, but probably not enough better to warrant the additional outlay.

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## COMMUTATOR DESIGN AND CONSTRUCTION.

BY ALTON D. ADAMS.

It is perhaps fair to say that direct-current dynamos and motors depend more for satisfactory operation on properly designed and constructed commutators than on any other one feature. Bad proportions in other parts of the dynamos may lower the efficiency slightly or unduly raise the temperature of some part, and yet the defect be hardly noticed in the practical operation of the machine, but if the commutator bars are of poor material, loose or of insufficient surface to transmit the required current, the heating, sparking and flashing are quite apt to be such as to interfere with or prohibit the operation of the machine. The commutator being that part of the dynamo subject to the most rapid wear and the only machined portion likely to require renewal, aside from the bearing bushings, it is important that electrical repair companies and machine shops in general should understand the special methods necessary in its construction and some of the main problems of its design. A few years since, commutators were frequently made with materials that have sinced proved unsuitable and were almost always proportioned for copper or other metallic brushes, so that when these older commutators came to the repair shop, as they are constantly doing, there is usually opportunity for improved constructions, especially if it is desired to replace the copper with carbon brushes. There are many points in the design of commutators which are necessarily connected with the electric and magnetic characteristics of the electric machines for which they are intended, and these points it is not the purpose to touch upon here, the object at this time being simply to point out the relation of ampere capacity to segment dimensions, certain considerations connected with insulation, and particularly features and methods of construction conducive to mechanical security in commutators.

It may be said, with little fear of contradiction, that by far the majority of commutator troubles are due to mechanical rather than electrical defects, and as a matter of design it has proven much simpler to procure suitable electrical proportions than to insure mechanical solidity.

### SEGMENTS.

Starting with the question of ampere capacity, it should be noted at once that the number of segments in a commutator is fixed by electric and magnetic considerations and has no direct bearing on current capacity. The amperes which a given commutator will properly transmit depend on the surface area of one segment, the kind of brush used, the number of segments that may be in contact with one brush and the material of which segments are made.

The number of segments on which a carbon brush may safely rest at any one time varies somewhat with the design of the particular machine, but in most direct-current dynamos and motors of 500 volts, or less, pressure, the width of the carbon brush may safely equal that of two segments, so that the brush may touch three segments at the same time.

A brush contact much wider than two segments is very apt to cause sparking, and in most cases a narrower brush unnecessarily reduces ampere capacity of contact. Some years ago, when metallic brushes were in general use, brush contact areas often had a current density of 100 to 125 amperes per square inch; later, fifty amperes per square inch was considered good practice for carbon brush contacts, and this density has gradually been reduced until now thirty amperes per square inch may be taken as a fair maximum. These densities for brush contacts are based on the use of pure drawn or forged copper for segments, on which good practice has now mainly settled, and if castings of copper alloys are used for segments the density at brush contacts should be diminished.

The inducements to use cast segments are now small, as drawn copper can be had that is truer to gage than castings, at a less price, and is certain to be free from blowholes. As the area of brush surface for a single segment depends on both length and width, the required contact area is sometimes secured by rather long, narrow segments, and at others with segments comparatively wide and short. The tendency in new work, however, is toward rather short, wide segments, resulting in commutators of quite large diameters as to their length, which are more easily made mechanically solid, and save also in length of shaft and base.

The long, narrow segment, with the resulting commutator of small diameter as to length, was more in favor on old machines, and it will often be found when one of these commutators is to be replaced that by the use of wider segments ample contact surface for carbon brushes can be secured in the original commutator length, while the increased diameter permits the use of improved methods of construction. In addition to the length of segments necessary for brush contacts it is desirable to allow from one-half to one or more inches in their length for the end motion of the commutator, and for clearance at each end. There must also be room for the proper attachment of armature conductors.

Concerning the maximum width of segments it may be said that carbon brush contacts, three-fourths and even seven-eighths inch wide, are being used, and it is doubtful whether these limits should be much exceeded in small machines, since difficulties of secure contact increase with the width of arc.

As commonly constructed, current enters and leaves a commutator once for each pair of poles, so that in a bipolar machine two segments must deliver the entire current, in a four-pole machine four segments, and so on, allowing for brushes wide enough to cover two segments.

In some multipolar machines the armature windings are so connected that but two sets of brushes are used, and for these cases each set must conduct the entire current, a construction which usually results in a commutator large compared with the machine to which it is connected.

Every commutator may be broadly divided into three parts, the segments which conduct the current, the insulation which separates the segments from each other, and from the clamps, and the shell or clamping parts which hold the numerous pieces together.

The segments, with their intermediate insulation, must form a true, hollow cylinder, the so-called segments being really circular sectors and the insulating sheets small parallelograms except as to the slight curve of their outside edges. The number of segments or sectors of which a commutator is made up fixes the angle between the sides of each segment, without regard to the insulating mica strips between them, and the width of the segment at its outside edge being determined for the desired ampere capacity of brush contacts and its radial depth fixed by considerations of wear and mechanical stiffness, the thickness at the inside edge may be readily calculated.

It is quite important that the sides of the segments have, as to each other, very nearly the correct angle, else the segments will touch the mica strips at only the inside or outside edges and it will be found impossible to hold them rigidly together. It is a good rule to require that the thickness of segments shall not vary from the standard dimensions for their thick and thin edges by more than one-thousandth of an inch in either direction, so that the thickness of segments shall not vary more than two-thousandths of an inch from each other. This degree of accuracy can readily be attained in either forged or drawn bars.

### INSULATION.

Nowhere else in electrical machines are the requirements as to insulating materials so exacting as in commutators. Among these are great strength to resist compression, high insulating properties, impunity to high temperatures, small power to absorb moisture and smooth wearing qualities; also capacity for accurate division. A variety of substances, as fibre, asbestos, wood and mica, have been used for commutator insulation in the past, but the mica has alone stood the test of time for general use in this capacity.

The mica used must be free from metallic impurities, and that used between the segments should be as soft as possible, the so-called amber mica being much used in this position, so as to wear at about the same rate as the segments.

The thickness of mica between the segments varies in practice from about .02 to as much as .06 inch, these differences being due in part to the design and pressures of various machines. For dynamos and motors of not over 500 volts pressure,

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whose proportions do not require some special dimensions for the mica between segments, a thickness of about .04 inch will in many cases be found satisfactory.

If the mica between commutator segments is too thick it gives trouble by extending beyond them, after a little wear, thus tending to lift brushes from contact with the segments and form an arc; while if too thin the carbon particles worn from the brush are apt to bridge across the mica and cause flashing. To insure that mica between segments will not flake out and will wear in the best manner it is well to divide it into strips .002 or .003 inch thick, and stick these together with shellac, using shellac also on the side of each segment when put together. The rings which insulate the segments from the commutator sleeve and clamping parts should also be of built-up mica, and usually from .04 to .06 inch thick.

COMMUTATOR SLEEVES.

The purpose of the sleeve is to hold the commutator segments rigidly in position, and unless it does so the machine becomes practically useless through excessive sparking and heating at the brushes. The design should be such as not only to hold the segments at a fixed diameter but also to maintain enough side pressure between them to securely clamp the mica. This side pressure, however, cannot be relied on to resist radial motion, which can only be prevented by a solid contact with mica rings both above and below.

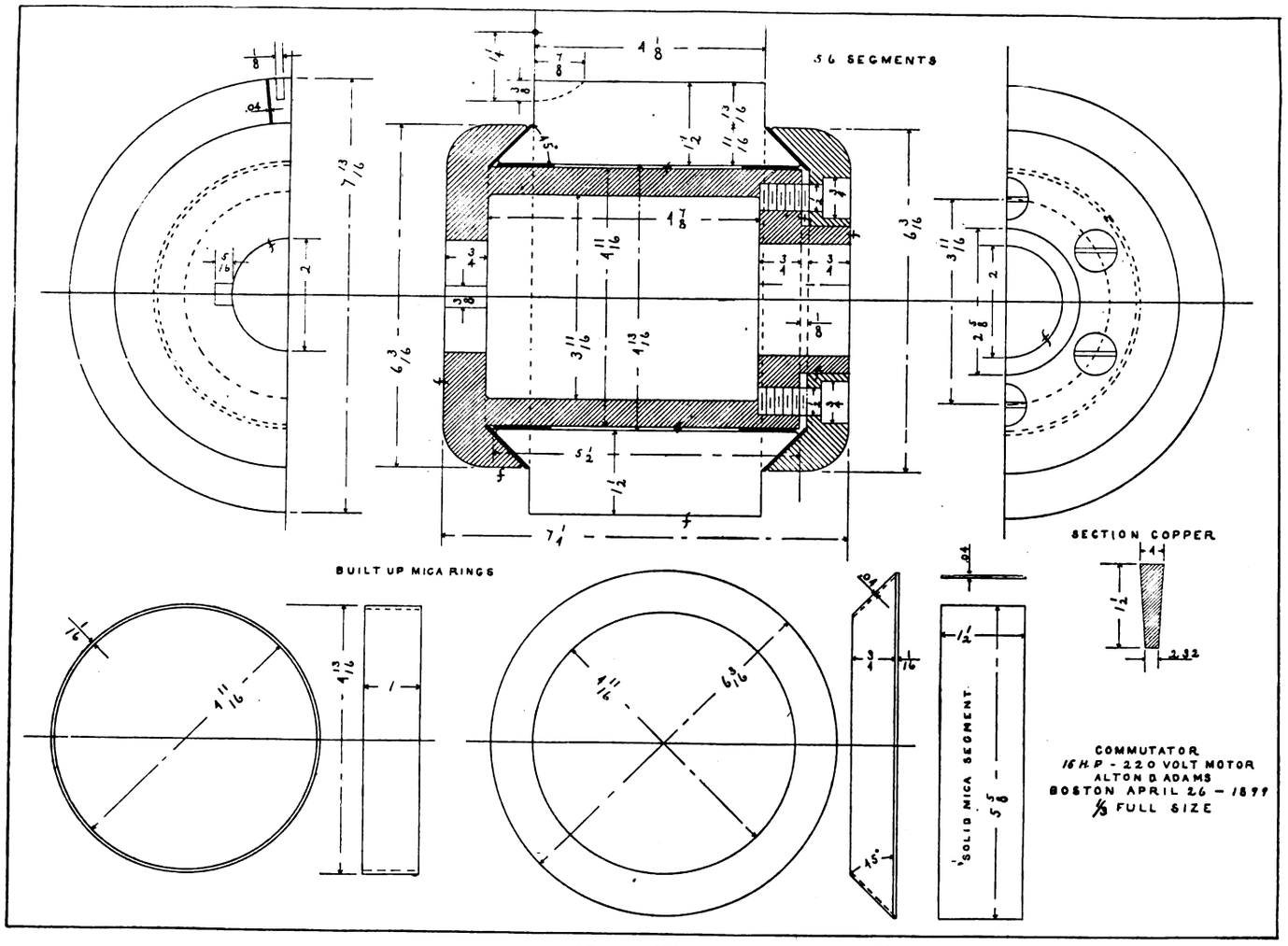
In order to secure the clamping action of the sleeve on the segments it is common to use either a single or a double taper on the clamping parts; with the single taper segments must bed solidly on to one straight surface, while with the double taper both holding surfaces come on at an angle.

Where large numbers of commutators are being made and special tools and jigs can be had, there is a slight advantage in the double taper construction, but in the manufacture of a few machines without much outlay for special equipment, the single taper form of clamp is to be preferred.

The parts of commutator segments which extend between the clamps may be either at each end or underneath, so that the segments extend out over the clamps. The first method makes a little longer commutator, but is quite easy to make, while the second is harder to follow with ordinary tools. Formerly it was the custom to hold the clamps in position by a screw collar on one end of the sleeve, but the later construction, which is also better and cheaper, employs several cap screws or bolts for the purpose. It is impractical to bring the segments to a proper degree of tightness with the clamps of the commutator sleeve, but this must be done with suitable rings or presses outside, and the commutator clamps subsequently employed to hold the compression thus gained. Cast-iron forgings and steel castings have been used for commutator sleeves and their clamps, but cast-iron is perhaps the most common and is suitable for the purpose if made sufficiently heavy. The very general use of carbon brushes now requires a more substantial commutator construction than was common when the metallic brush was in general use, as it is impractical to use carbon brushes on commutators having high and low bars, since the brushes, in passing over these bars, are lifted from their contacts, breaking the current and causing destructive sparking and heating.

The metallic brush, when lifted at one point, usually retains contact at others because of its yielding nature, but the carbon brush may be so lifted as to touch at a bare point.

Troubles with high and low commutator bars and carbon brushes usually grow




DESIGN FOR THE COMMUTATOR OF A 15-H. P., 220-VOLT MOTOR. SCALE, ⅛ ACTUAL SIZE.

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worse very rapidly, as the heat that results from sparking causes excessive expansion of the bars, this tends to loosen them more and the actions become cumulative.

After a commutator is completed it may be tested for tightness by holding a piece of hard fibre on each segment and striking the fibre a fair tap with a light hammer, then feeling over the joints between segments and mica to see if they have developed high and low bars.

### 60-AMPERE 220-VOLT COMMUTATORS.

To illustrate some of the features of design and construction pointed out, take the case of a commutator for a 60-ampere 220-volt dynamo or motor of the bipolar type.

As this commutator is to deliver 60 amperes, the actual area of brush contacts for each set should be equal to $60 \div 30 =$ 2 square inches, on the basis of 30 amperes per square inch of contact. Allowing the width of brush contact to be .8 inch, the length of contact surface becomes $2 \div 8 =$ 2.5 inches, and adding 1⅝ inches for armature connections, end play of commutator and clearance, makes the total length of the top of segment 4⅛ inches.

It having been decided to let each brush contact cover about two segments, the thick edge of bars for this commutator, before they are turned to circular shape, is taken at .4 inch. To secure great mechanical solidity the radial depth of bars is taken at 1.5 inches, and it is now necessary to calculate the thickness of the bar at the inside or thin edge, for which the number of segments in the commutator must be known.

It having been decided for reasons connected with magnetic and electric features of design to put 56 segments or bars into this commutator, the angular space occupied by each bar, or the angle between its sides, must be equal to 360 degrees divided by 56, or 6 degrees and 26 minutes, neglecting the mica, which does not affect the angle of the segments.

Now it is evident that the tangent of one-half the angle of the bar is equal to one-half the difference between the thick and thin edges divided by the depth of the bar, that is $\tan [(6° 26') \div 2] = \frac{X}{1.5}$, when X is taken as one-half the difference between the thick and thin edges. Solving above equation for the value of X gives .084, so that the dimension for the thin edge of the bar is $.4 - (.084)\ 2 =$ .232 inches. This bar is to be cut from drawn commutator stock, and as the armature leads are small they will be soldered directly into slots cut in each bar by a milling machine. Insulating strips between segments and the rings are of built-up mica of the dimensions shown on the previous page, which experience has proven satisfactory in similar cases.

In case the mica rings are found too thin at any point when the commutator is put together, the necessary amount of mica is added.

## AMERICAN TELEPHONE PRACTICE.

### TESTING.*

BY KEMPSTER B. MILLER

In a large class of tests—that is, those requiring quantitative measurements—there are three distinct subdivisions, which are as follows: Tests for resistance or conductivity, tests for capacity and tests for insulation. Tests for the location of faults in lines always depend on the application of one or more of these.

There are three principal methods of making resistance tests: First, by the use of a Wheatstone bridge, which is accurate for all resistances except those very large or those very small. Second, the fall of potential method, which is of value in measuring very small resistances, as of a large conductor, such as a trolley-wire or heavy feeder. This method has little use, therefore, in telephone work where all conductors are comparatively small. Third, by the use of a sensitive galvanometer in series with a battery. This method is the most accurate for the determination of extremely high resistances and is, therefore, of great use in measurements of insulation resistance.

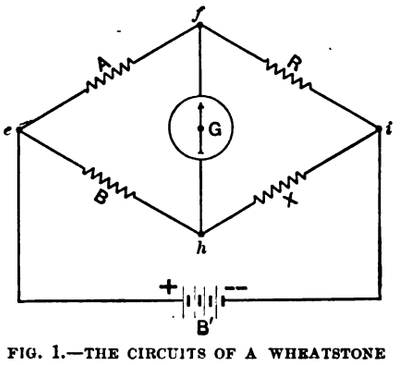



FIG. 1.—THE CIRCUITS OF A WHEATSTONE BRIDGE.

For general resistance measurements the Wheatstone bridge is the most suitable, being very accurate and exceedingly simple in manipulation. In order to appreciate the possibilities of this instrument its underlying principles should be understood. In Fig. 1, A, B, R and X represent resistances. G is a galvanometer or instrument for detecting the flow of current through it. The four resistances are connected together as shown, the galvanometer being connected in the "bridge" between the juncture of A and R and B and X. A battery, B', is connected between the junctures of A and B and of R and X. Each resistance, A, B, R or X, forms what is termed an arm of the bridge.

The two fundamental laws upon which the action of the bridge is based may be stated as follows:

1. No current will flow between points of equal potential; and

2. The drop in potential along the various parts of a conductor is proportional respectively to the resistances of those parts.

* From a book to be published by the American Electrician Company.

Referring again to the diagram, it is evident that a current from the battery flows to the point, e, where it divides, part flowing through A R and part through B X, after which they unite and pass to the negative pole of the battery. But what of the galvanometer? Evidently by Rule 1 the only time at which no current will pass through it will be at the time when the points, f and h, are at the same potential. By Rule 2 these points will be at the same potential only when A bears the same relation to R as B does to X.

That is

$$A : R :: B : X, \text{ or, by alteration, } \frac{A}{B} = \frac{R}{X}.$$

A little algebra will render the above evident if not so already.

Call ei the drop of potential between the points e and i, ef that between e and f, and eh that between e and h.

Then

$$ef : ei :: A : A + R \text{ by Rule 2.}$$

Therefore,

$$ef = \frac{A}{A + R} ei.$$

Similarly

$$eh = \frac{B}{B + X} ei.$$

For a condition of equal potentials at f and h so that no current will flow through the galvanometer, e f must = e h.

Then

$$\frac{A}{A + R} ei = \frac{B}{B + X} ei$$

$$AB + AX = AB + BR.$$

$AX = BR$, dividing by BX, we have $\frac{A}{B} = \frac{R}{X}$, which is the equation of the ratios between the resistances of the arms of the bridge, to insure no flow of current through the galvanometer.

The resistance to be measured forms the arm X of the bridge, and in order to determine its value the resistances in the various arms are adjusted till no current flows through the galvanometer. Then the equation just derived holds good and may be solved for X,

$$\text{thus } X = \frac{B}{A} R.$$

The arms A and B are best termed the "ratio arms" of the bridge and arm R the rheostat arm.

In commercial forms of the Wheatstone bridge, A and B are usually so arranged that each may be given the values, 10, 100, and 1000 ohms, and in some cases 1 ohm and 10,000 ohms also. The ratio arms, A and B, may therefore be adjusted to bear any convenient ratio to each other from $\frac{10}{1000}$ to $\frac{1000}{10}$, or, in some instances, from $\frac{1}{10,000}$ to $\frac{10,000}{1}$. The rheostat arm is in reality a rheostat capable of being adjusted to any value from 1 to about 11,000 ohms.

In some bridges, sealed batteries are furnished with and form a part of the instrument. In those having no battery,

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suitable binding posts are provided, usually marked BB, between which the batteries may be connected. Other binding posts, usually marked XX, are furnished for connecting the terminals of the unknown resistance to be measured.

Two keys are usually furnished, one in the battery circuit and the other in the galvanometer circuit. Each keeps its circuit normally open.

The operation of the bridge is very simple. First some ratio between the arms A and B is determined upon. The battery is then connected between the proper binding posts, and likewise the resistance to be measured is connected between its binding posts.

The battery key is first depressed and then the galvanometer key. A deflection of the galvanometer needle will take place which by its direction will after a few trials show whether the resistance in the rheostat arm is too great or too small. The rheostat is adjusted accordingly until the galvanometer needle shows no deflection upon the operation of the keys. We then know that our equation

$$\frac{A}{B} = \frac{R}{X} \text{ holds good,}$$

and consequently

$$X = \frac{B}{A} \times R.$$

That is, the unknown resistance is equal to the ratio between B and A multiplied by the resistance in the adjustable arm.

Considerable judgment may be exercised in the choosing of the appropriate ratio in the ratio arm to obtain the greatest accuracy. Obviously if a very high resistance is to be measured the ratio should be large, and vice versa.

In bridges having resistances of 10, 100 and 1000 ohms in the ratio arms, the following values in arms A and B will give the best results:

| Resistance to be measured. | A arm. | B arm. |
|---|---|---|
| Under 100 ohms | 1000 | 10 |
| 100 to 1000 ohms | 1000 | 100 |
| 1000 to 10,000 ohms | 1000 | 1000 |
| 10,000 to 100,000 ohms | 100 | 1000 |
| 100,000 to 1,000,000 ohms | 10 | 1000 |

As to the accuracy of measurements attainable by the use of the Wheatstone bridge, the following table represents the claim of one reliable manufacturer:

| | | | | | |
|---|---|---|---|---|---|
| .01 | of an | ohm | to an | accuracy of | 1 p.c. |
| .1 | " | " | " | " | ½ " |
| 1 | ohm | " | " | " | ⅛ " |
| 10 | ohms | " | " | " | 1/15 " |
| 100 | " | " | " | " | ⅛ " |
| 1000 | " | " | " | " | ⅛ " |
| 10,000 | " | " | " | " | 1/15 " |
| 100,000 | " | " | " | " | ¼ " |
| 1,000,000 | " | " | " | " | 5 " |

If using the 110-volt lighting circuit as battery power 1 megohm may be measured accurate to ½ per cent.

There is no doubt but that with a well-made bridge with a sensitive galvanometer, these results may be equaled if not surpassed. Great care must be taken in using a voltage as high as 110, as there is danger of burning out the coils. Such high voltage should be used only in measuring very high resistances, and the ratio arms should be adjusted to give as high a multiplying ratio as possible.

It is frequently found that a current that it is desired to measure is so large that it sends the spot of light completely off the scale, thus rendering the measurement of the deflection impossible. In order to increase the range of the galvanometer so as to make it available for measuring both large and small currents, certain resistances called shunts may be placed in parallel with the galvanometer coil as in Fig. 2. The resistance of the shunt being known, it is easy to calculate the amounts of the currents that pass through the galvanometer coil and the shunt.

Calling $R_g$ the resistance of the galvanometer, $R_s$ that of the shunt, $C_g$ the current through the galvanometer, $C_s$ that

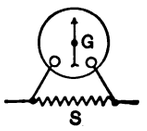



FIG. 2.—THE CONNECTION OF A GALVANOMETER AND SHUNT.

through the shunt, and C the total current through both, then

$$C = C_g + C_s.$$

Also when E is the difference of potential betwen the common terminals of the galvanometers and shunt,

$$C_g = \frac{E}{R_g} \text{ and } C_s = \frac{E}{R_s}.$$

$$E = C_g R_g = C_s R_s. \text{ Hence } C_s = \frac{C_g R_g}{R_s}.$$

Substituting this value of $C_s$, in the first equation, we have

$$C = C_g + \frac{C_g R_g}{R_s} = C_g \left(1 + \frac{R_g}{R_s}\right) = \frac{R_s + R_g}{R_s}.$$

This quantity $\frac{R_s + R_g}{R_s}$ is called the multiplying power of the shunt, because it represents the number by which the




FIG. 3.—A COMMERCIAL FORM OF SHUNT BOX

current through the galvanometer must be multiplied, in order to give the value of the current being measured.

Shunt boxes are usually provided for a given galvanometer with a number of coils specially arranged to give such convenient values of the multiplying powers, as 10, 100 and 1000. For this purpose the various coils of the shunt box have resistances of 1/9, 1/99 and 1/999 of the resistance of the galvanometer.

To better show this rule, assume that a multiplying power of 1000 is desired, then

$$1000 = \frac{R_s + R_g}{R_s}$$

$$1000\,R_s - R_s = R_g$$

$$R_s = \frac{R_g}{1000 - 1} = \frac{R_g}{999}.$$

A commercial form of shunt box is shown in Fig. 3, the various multiplying values of the shunt being obtained by plugging the block corresponding to the multiplying power desired.

For moderate deflections, the current traversing the coils of a reflecting galvanometer may, without sensible error, be taken as proportional to the deflection of the spot of light on the scale, or to the deflection read through the telescope. The current is, of course, inversely proportional to the total resistance of the circuit, and from this it follows that the deflections are inversely proportional to the resistance. This fact enables the galvanometer to be used for measuring unknown resistances by comparing a deflection obtained when a given e. m. f. acts through a known resistance with that obtained when the same e. m. f. acts through an unknown resistance.

The general method of measuring resistances by the use of a galvanometer is to note the deflection obtained with a given battery and a known resistance in the circuit, and from this to compute what is called the working constant. This working constant may be defined as the number of scale divisions deflection that would be obtained by causing the current from the given battery to pass through the galvanometer and a resistance of one megohm. Of course such a deflection as this can exist in our imagination only, but it serves, nevertheless, as a convenient standard upon which to base our calculations. Having obtained the working constant, a reading is taken of the deflection produced by passing the battery current through the galvanometer in series with the unknown resistance. As the deflections are inversely proportional to the resistances, the unknown resistance is then readily computed.

If measurements of comparatively low resistance are to be made, then the resistance of the battery and of the galvanometer must be taken into consideration as well as that of the resistance placed in circuit with them, but as the measurements here considered will be those of very high resistances only, the resistance of the battery and of the galvanometer may be neglected. For the purpose of taking the constant connections are made as shown in Fig. 4, where B is the battery, G the galvanometer, S the shunt and R the known resistance. Usually the value of R is 1/10 of a megohm, or 100,000 ohms. With the 1/999 shunt a certain deflection will be obtained when the circuit is closed. Obviously, if the shunt were not present the deflection would be 1000 times as great, because only 1/1000 of the current passes through the galvanometer. Therefore the total deflection, if it could be measured, that would be produced

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through the galvanometer and the 100,000 ohms resistance, would be the deflection noted multiplied by 1000. If, now, the resistance, R, had a value of 1 megohm instead of 1/10 megohm, the deflection would have been only 1/10 as great as

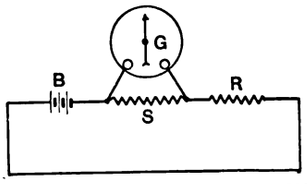



FIG. 4.—CONNECTIONS FOR CALIBRATION OF SHUNTS.

this. Therefore to find the number of scale divisions of deflection which the galvanometer alone would give with 1 megohm in circuit, we multiply the deflection noted by 1000 and by 1/10.

In general we may say: To find the working constant, multiply the deflection obtained by the multiplying power of the shunt, and by the value of the known resistance in megohms.

As a numerical example let us assume that with the 1/999 shunt and the 1/10 megohm resistance, we obtain a deflection of 200 scale divisions, then the working constant is

$$200 \times 1000 \times \frac{1}{10} = 20{,}000.$$

In other words, 20,000 would be the number of scale divisions obtained were the entire current from the battery allowed to pass through the galvanometer with one megohm in series.

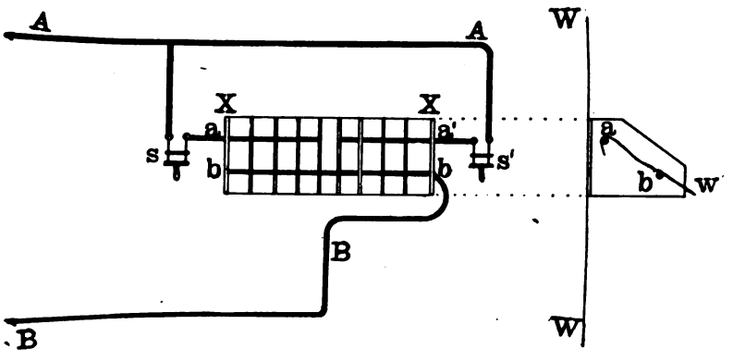
## A SIMPLE FORM OF RAILWAY POWER HOUSE LIGHTNING ARRESTER.

BY A. E. KENNELLY.

A simple and convenient form of central station lightning arrester, designed and installed by Mr. W. T. Cook, Manager of the Louisville Traction Company at Louisville, Ky., deserves some notice from those interested in street railway service. It does not involve any new principle, but is readily set up on the spot with the aid of a carpenter. It is illustrated in the accompanying illustration. A front elevation is shown at the left-hand side, and a vertical section at the right hand side of this sketch.

Upon the wall, WW, of the station, near the switchboard, is a box, XX, with nine vertical partitions, each lined with asbestos paper. Into this box pass three copper rods, a, a', and b. The two former are connected through switches, s, s', with a heavy copper conductor of 300,000 circular mils section, leading directly to the positive bus bar of the switchboard, immediately above the main generator switches. The lower rod, bb, is connected directly to the negative or main return bus bar by a copper conductor, No. 0000 A. W. G., without any intermediate switch. In any partition of the box, a No. 16 A. W. G. double cotton covered copper wire is hung, as shown at w, on the right hand side. The upper end of the wire is bared and is hooked around the rod, a, while the lower end of the wire is left covered and is allowed to rest by its weight on the ground rod, b. With the switches, s, s', closed, the full station pressure of 550 volts will be brought to bear between the rods, a and b, which are 10 inches apart, and thence upon the double thickness of cotton covering on the wire, w, at the contact with the lower bar. The cotton covering of the wire, w, is amply sufficient to stand a pressure of 550 volts indefinitely, but should an electrical disturbance of high pressure arrive at the station, due to a lightning discharge, the pressure will disrupt the cotton insulation and produce a momentary short circuit through the arc and the wire, w, between the positive and negative rods, a and b. The melting and volatilization of the wire takes place instantly, and the arc is almost instantly extinguished by reason of its being unable to sustain itself over the 10-inch gap.

The reason for the use of two separate




A SIMPLE LIGHTNING ARRESTER.

positive bars, a, a', is that a wire, w, can be replaced on either side by opening a switch on that side, and after the wire is in position the switch can be closed without danger of burning up the wire in the face of the operator. Eight partitions were used in this apparatus, so as to enable eight different wires to be used in parallel at the same time, but in practice only two wires were employed, one on each side.

Mr. Cook states that during the winter time the wires remain in position for months unaffected, but during a thunderstorm it is usual for one or both wires to be burned up. The flash is so soon dissipated that no trouble is experienced at the generators. Mr. Cook states that the apparatus has worked satisfactorily for more than five years.

## SOLDERING ALUMINUM.

On account of the number of inquiries for directions for soldering pieces or wires of aluminum the following instructions are reprinted from the handbook of the Pittsburgh Reduction Company.

In advance it might be said that wire connections are best made by means of some form of coupling device such as the McIntyre joint, which is made of aluminum, for this purpose.

Soldering aluminum has so far proven a difficult task. Most solders, such as ordinary hard solder composed of silver and tin, or ordinary soft solders, composed of lead and zinc, will not stick, owing to the high heat conductivity of aluminum. The heat is very rapidly drawn away from any of the molten solders, causing them to freeze before flowing sufficiently. Good joints can be made, however, by carefully cleaning the surface to be joined, and with very hot soldering bits, or careful work with the blow pipe, "tinning" the surfaces with some of the special solder used, before attempting to join the metals; using special alloys for the solder. Several such solders are successfully used, pure tin with a little phosphor tin being the basis of the majority of such solders. Soldering bits of nickel are best to be used and specially good work has been done with those kept hot by a gasoline torch or electric appliance.

Special care should be taken to clean the surface to be soldered; this can be successfully accomplished by the mechanical means of scratch-brushing, scraping or filing the surfaces, thus exposing fresh metal free from the thin film of oxide of aluminum and the oxide of silicon (silica), which forms a protecting coating over the surface of the metal, preventing either the soldering or the plating of the aluminum.

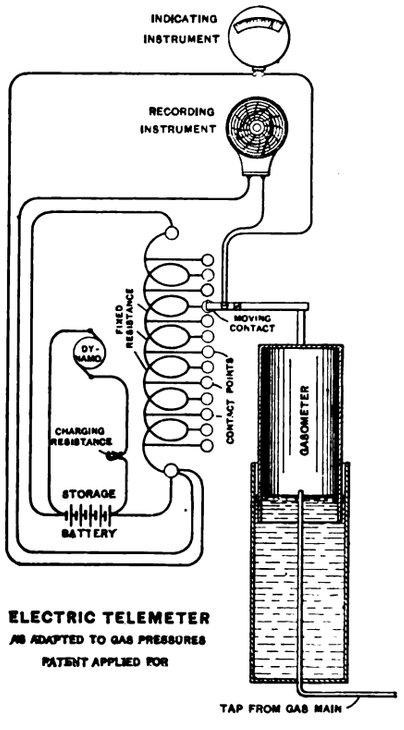
Another way to clean the surface of aluminum for either soldering or plating is to dip the sheets into nitric acid diluted with three times its bulk of hot water, and which has had just enough hydrofluoric acid added to it to make the solution act on the surface of the metal, this action being denoted by the evolution of gas bubbles. The solution can be kept in either a wooden or lead-lined tank, and the amount of hydrofluoric acid added need be only small, say less than five, or, at most, ten per cent. of the bulk of the solution. The hydrofluoric acid required is the cheap fluid of commerce sold in lead jugs and costing about five cents per pound.

The aluminum, after being cleaned in this dilute nitric and hydrofluoric acid solution, is again dipped into hot water for rinsing and dried in hot sawdust; it is then cleaned so that either solder or plating solutions can be readily applied.

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## THE USE OF ELECTRICITY IN GAS WORKS.

Mr. H. G. Field describes in "The Technic" an isolated plant installed under his direction for the Detroit City Gas Company. The plant consists of a small gas engine driving a dynamo supplying lights, particularly in such dangerous places as the Pintsch compressor room, tank house, purifier cellars and ammonia room, where artificial lights of other kinds would be out of the question, owing to the inflammable and explosive nature of the atmosphere. Keyless sockets are used, controlled by switches located outside, long extension cords with waterproof sockets and heavy lamp guards being provided to facilitate inspection in case of trouble in tanks, purifier rooms or other places where without them it would be necessary to work in the dark. An interesting piece of apparatus described in the same article is indicated in the accompanying diagram of connections. Its purpose is to

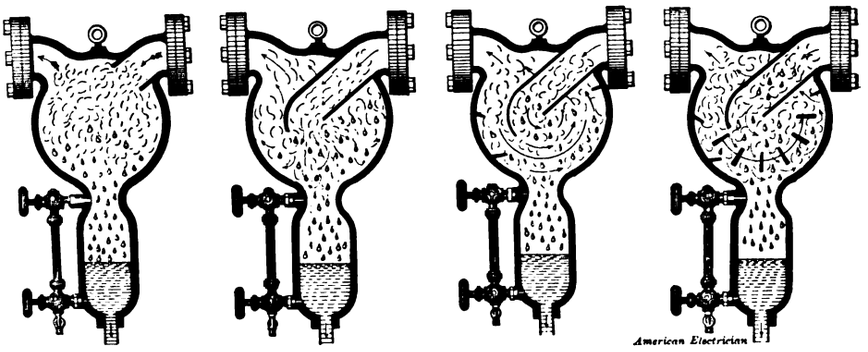



ELECTRIC TELEMETER
AS ADAPTED TO GAS PRESSURES
PATENT APPLIED FOR

indicate and record at any point the gas pressure as measured either on the premises or at any distant location. The instrument consists of a gasometer, to the bell of which is attached a moving contact sliding over contact points, connected, regulator-head style, to a resistance. A definite current is passed through this resistance by means of a constant potential, indicated in the figure by a storage battery. The difference of potential between the moving contact and the lower terminal of the resistance is proportional to the pressure, and this potential difference can be tapped off to indicating or recording instruments, or, as indicated in the figure, to both. The article states that the use of this arrangement for indicating or recording at a distance any pressures or positions has been patented.

## OIL AND GREASE EXTRACTORS.

There is hardly an imaginable situation where it is not possible to improve things by the use of grease extracting machinery in connection with steam boilers and steam using. The number of grease extractors now in the market is almost infinite, and it must be said that almost




I. By Expansion. II. By Reverse of Current. III. Centrifugal. IV. Baffle Plate.

FIG. 1.—TYPES OF GREASE EXTRACTORS.

every one of them possesses more than one point of excellence. There are numberless conditions met with in practice that require an almost endless variety of mechanisms to meet, and it is for this reason that the very many forms of grease extractors in the market are all necessary.

Many forms of extractors are made for grease alone, other forms are for water only, while many extractors work to separate both water and grease. Although there is an almost endless variety in form and appearance, all the separators work upon one or more of a few fundamental principles, and the several forms may be classified and divided into the following forms, viz.: Separation by expansion, by reverse of current, by centrifugal force and by baffle plates. The four engravings which constitute Fig. 1 represent

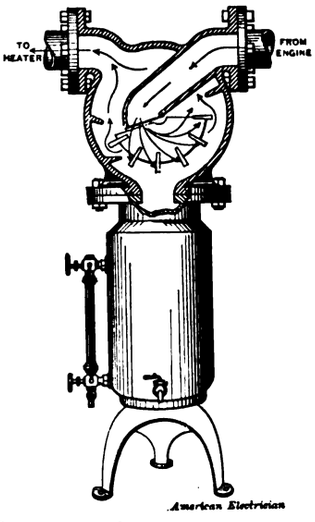



FIG 2.—JENNINGS' COMBINE OIL OR GREASE SEPARATOR.

types of these four methods, to which may be added the "Turkish Towel" separator, the "Drip Pan," the "Wire Screen" type, and a few other varieties which will develop from combinations of the varieties above noted, and which will be described and classified according to their characteristics.

For the above engravings we are indebted to a catalogue of Jennings Separators, published by the Watson & McDaniel Company, Philadelphia, Pa., which shows the methods noted above, and also a combination of the four methods into one separator, shown by Fig. 2, and known as the Jennings' Combined Oil or Grease Separator. This device is said to be free

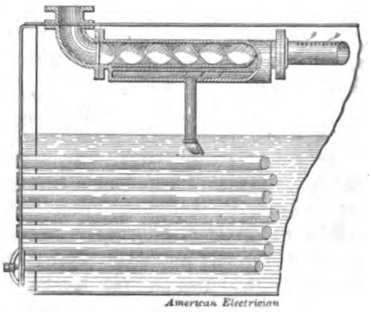



FIG. 3.—MOSHER SEPARATOR.

from back pressure, and is made either vertical or horizontal.

The centrifugal class is perhaps the largest, therefore we will give attention to that first. But the centrifugal type may be subdivided into quite a number of separate and distinct divisions accordingly as the grease is thrown off tangentially or spirally. Figs. 3 and 5 will illustrate this point. Fig. 3 shows the spiral form of grease delivery, and Fig. 5 presents the tangential principle in one of its many forms.

The form of apparatus shown by Fig. 3 may be a boiler fixture or it may be placed for different kinds of duty in lines of steam or exhaust pipes. This device is known as the Mosher Separator, and is manufactured by Charles P. Mosher, New York City. When placed inside the boiler, its office is solely to separate water from the dry steam. This is also its function when placed in a steam pipe, but when connected into a line of exhaust piping, oil and water both will be separated from the uncondensed steam. Fig. 4 shows the

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method of applying this separator in a line of pipe to remove either steam or oil, and the engraving also illustrates the action of the separator so as to make it easily understood. This engrav-

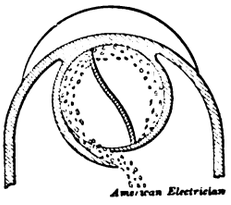



FIG. 4.—ACTION OF SEPARATOR.

ing shows the spiral by means of which a whirling action is given the flow of steam in the pipes, and the manner in which the oil and water are thrown out by centrifugal force during the whirling action mentioned, and it is also shown how the water and oil are "peeled" or

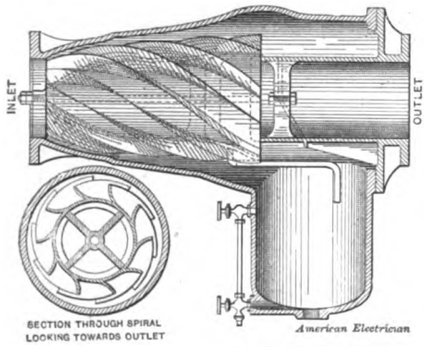



FIG. 5.—DE RYCKE GREASE EXTRACTOR.

"shaved" from the dry steam by action of the edge, which in this separator is a special point.

Another form of "centrifugal" grease extractor is shown by Fig. 5—the De Rycke, made by Joseph De Rycke, of New York City. This separator consists, as shown, of a casing in which

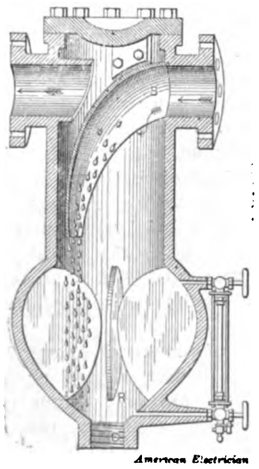



FIG. 6.—LIPPINCOTT OIL EXTRACTOR.

is a hollow cone fitted with knife-edged spiral wings. The space between the shell and cone at its smallest part is equal to the diameter of the exhaust pipe, and the space between the cone and the outlet is greater in area than that of the exhaust pipe. On entering the extractor, the steam is thrown outward by the cone and given a centrifugal motion by the wings. At the end of the cone the motion of the steam is reversed and the heavier particles are thrown to the outward end of the shell and into the cone, whence they are carried off by a suitable pipe. The cone is stationary and is held securely by lugs.

Fig. 6 shows another type of the inverted syphon extractors, but there is added a baffle plate, placed vertically which prevents the steam from distributing the water, and possibly splashing it back into the upward column of steam, in which it might again be caught and again carried on by the steam. A large area is provided around the radial, vertical baffle plates, in order that steam may pass with the least possible disturbance or loss of pressure.

In the Lippincott Separator the water strikes a curved deflector, without any tendency to spray, and is instantly deflected down to the reservoir, while the steam readily passes around the sides of the deflector. The action of the two types of separators shown may be demonstrated

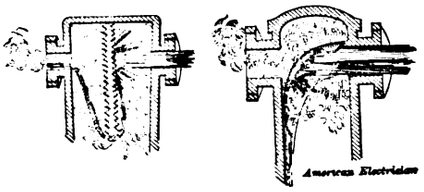



FIG. 7.—THE "WRONG WAY."

FIG. 8.—THE "RIGHT WAY."

by means of two sheet metal plates, one flat and one curved, held under any convenient water faucet.

The manufacturer of this separator illustrates this point by the two engravings presented herewith, as Figs. 7 and 8. In Fig. 7 is illustrated what Mr. Lippincott calls the "wrong way," and in Fig. 8 he presents his "right way." In the first

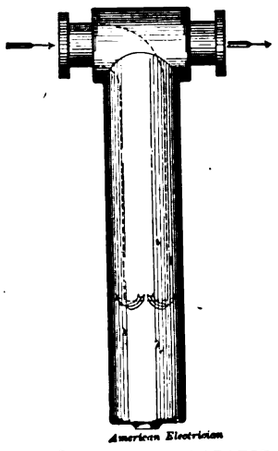



FIG. 9.—CLIMAX SEPARATOR.

engraving the steam and grease is shown impinging directly against a flat baffle plate, the oil flying off in every direction, only to be caught again to a great extent by the current of steam and carried on with the vapor again. In Fig. 8, the "right way," the extracted oil is carried down to the receiver by the guide, which is really a curved baffle plate. The full title of the device shown by Fig. 6 is a "Steam Separator and Exhaust Grease Extractor." It is made by A. C. Lippincott, New York City.

Probably the simple form shown by Fig. 9, which represents a Climax Separator made by Best, Fox & Co., Pittsburgh, Pa., is the fundamental form of most of the oil separators, both centrifugal and otherwise. In this form there is simply a pipe within a pipe, the steam entering the smaller, passing into the larger in a downward direction, centrifugal force acting at this point serving to carry the grease down into the reservoir while the steam makes the turn and escapes through the pipe to continue its

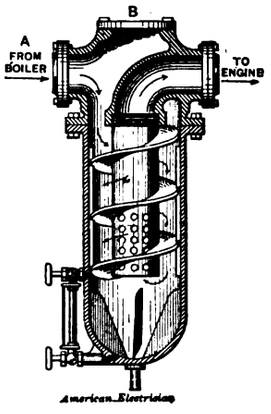



FIG. 10.—SIMPSON SEPARATOR AND TRAP.

journey to the engine. Upon the simple fundamental form there has doubtless been built most of the grease extractors now in the market—all the centrifugal, and many other forms besides.

A development of the centrifugal extractor is shown by Fig. 10, which represents the Simpson, made by the Keystone Engine & Machine Works, Philadelphia, Pa., in which, the steam taking a spiral course between the threads, causes the water and grease to be thrown by centrifugal force against the outer walls,

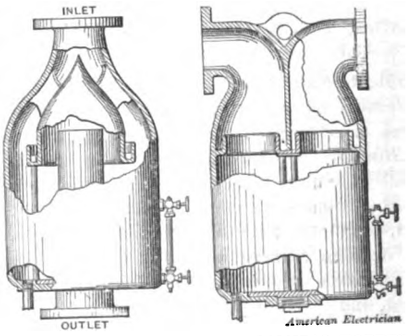



FIG. 11.—VERTICAL AND HORIZONTAL HOPPER OIL ELIMINATOR

while the dry steam goes through the small holes to center of pipe. Steam can enter either at A or at B, as convenience may require, and the water column at the bottom shows the quantity of water in the reservoir at all times.

There is a very close connection be-

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tween the centrifugal extractors, especially when they are assisted by gravity as in the case of Fig. 9, and some of the inverted syphon and baffle plate types. In fact, Fig. 9 may be called an inverted syphon concern, and it may also be termed a "baffle plate" construction if it be allowed that the "plates" are rolled into tubes—the effect is the same, it is only a difference in the details of construction.

Fig. 11 may be included in the inverted syphon type, but aside from this there is a very important feature in the gutters shown in the engravings, said gutters being always filled with water, which intercepts all entrained water and grease. In the vertical type the steam enters the device at the top and the water or oil fol-

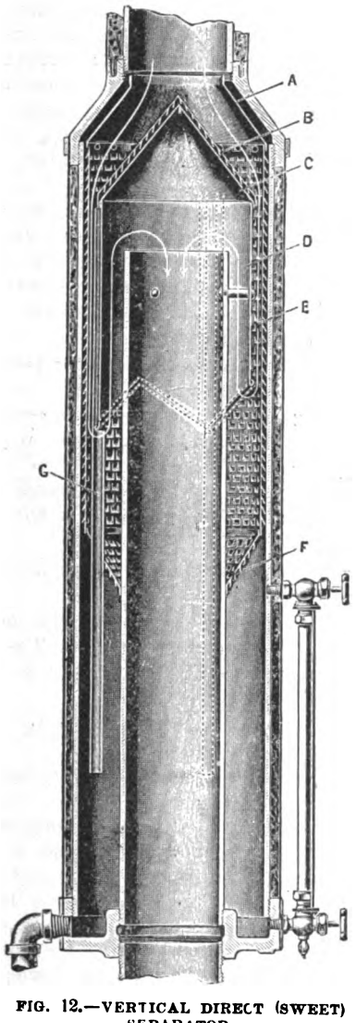



FIG. 12.—VERTICAL DIRECT (SWEET) SEPARATOR.

lowing the surface passes to the bottom of the separator and is intercepted by the water. The water or oil in the steam not following the surface will strike the exterior of the cone and will be caught by the gutters at the bottom of the cone and carpipe. In the horizontal separator the steam may enter at either side, both being alike. In this separator, as in the vertical, the water or oil is caught by the gutters and carried to the bottom by the pipes shown.

One of the most important features of this device is that it is so designed that the steam is gradually expanded into a chamber ten times the area of the pipe and on its outward passage is gradually reduced back again to the original area. This arrangement reduces the velocity of the steam in the working part of the separators to one-tenth of that in the pipes, and it is claimed that the separation takes place with the least possible amount of friction, the interior of the separators being perfectly smooth. These machines are manufactured by the Hoppes Manufacturing Company, Springfield, Ohio.

Quite different in principle, and loaded with additional grease catching apparatus, is the "Direct" Separator made by the Direct Separator Company, Syracuse, N. Y., and illustrated by Fig. 12. This device combines in the most admirable manner not only the centrifugal, but the baffle plate, the perforated plate and perhaps several other methods of grease and water extraction. The inverted syphon is there, as the engraving shows, and at the very instant of the "whip-snap" which the steam makes as it passes the bottom of the syphon, the centrifugal force developed throws the water and grease into or upon a perforated screen.

Other forms of separators will be discussed in succeeding articles.

## Letters on Practical Subjects

### A Peculiar Arc Line Trouble.

*To the Editor of American Electrician:*

Sir.—Answering Mr. Hervey Scofield's communication appearing in the July issue, I will say that the same trouble happened here, that is, opening and closing without apparent cause, but we found a loose connection on one of the switch blades, and if Mr. Scofield will examine his dynamo and switchboard connections I think he will probably find his trouble. If not, I would recommend examining the hanger boards.

Geo. M. Ockford, Jr.

Ridgewood, N. J.

### The Telephone as a Burglar Alarm.

*To the Editor of American Electrician:*

Sir.—I have lately made use of some telephone apparatus for an alarm system, a description of which may be of interest to your readers.

A bank vault was connected up to a room of one of the officials in the same building so that any one attempting to enter when switches are on would turn in an alarm. In the vault is a very sensitive telephone transmitter, the primary current of which is controlled from the receiving end. At the receiving end is a complete telephone and necessary switches. When an alarm comes in, the person at the receiving end puts current through primary of induction coil of vault transmitter and with his receiver can hear distinctly the slightest noise in or near the vault. A simpler alarm has been used, but it was found that false alarms came in. With the present arrangement it is positively known that the vault is being tampered with before calling the police. The alarm is used at night only.

A. H. Ingraham.

South Chicago, Ill.

### Brush Discharges from High Tension Lines.

*To the Editor of American Electrician:*

Sir.—I noticed in the July number of your paper, page 354, vol. XI., an inquiry signed by S. D. W., relating to high potential transmission and insulation, with some points in the answer of which I beg to differ.

The Telluride Power Transmission Company of this city has for two years been successfully operating a 1000-h. p. three-phase alternating plant, transmitting power to Mercer, a town about 55 miles distant, at a potential of 40,000 volts. The line is of bare copper wire, No. 5 gage; triple-petticoat glass insulators are used, and there are no brush discharges of which you speak. The loss is very small.

Robert Fairbanks.

Telluride Power Transmission Co., Provo, Utah.

### To Find the Turns in the Shunt or Series Coil of a Compound Dynamo.

*To the Editor of American Electrician:*

Sir: In testing dynamos it is sometimes necessary to find the number of turns in the shunt or series winding without unwinding the coil. The writer while experimenting with some dynamos, devised the following wrinkle. If the machine is a compound wound, one or the other of its windings is likely to be known and by a simple method the other can be found. All that is required is a good voltmeter and ammeter. The dynamo is driven at a constant speed, and a voltmeter is put across the brushes. An ammeter is connected in series with the coil in which the turns are known, a measured current is sent through this coil and an e. m. f. will be generated which will be read on the voltmeter. Next a current is sent through the unknown coil until the same e. m. f. is obtained. If we have the same e. m. f. we must have the same magneto-motive force in ampere turns. Multiplying the turns in known coil by the amperes we get the ampere turns, and this divided by the current in the unknown coil will give the turns in the unknown coil. For example, a compound-wound machine with 50 turns in series coil and a current of 200 amperes gave a voltmeter reading of 25 volts. It required 5 amperes to produce the same reading of 25 volts in the unknown coil. The ampere turns of the known was $200 \times 50$, or 10,000 ampere turns, and as the unknown must have been the same, dividing by the current in unknown winding gives $10,000 \div 5$, or 2000 turns in unknown.

Leslie E. Carpenter.

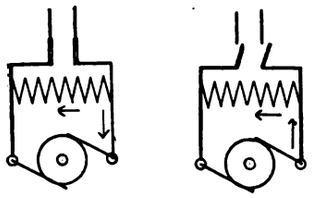
New York City.

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# Electrical Catechism

*366. How is the magnetization of a shunt motor maintained after the line current is cut off?*

The magnetizing current is caused by the e. m. f. due to the rotation of the armature in the magnetic field. When the motor is driven by current from the line, an e. m. f. is generated in its armature just as in a dynamo. When the machine is running as a motor, this e. m. f.



is in a direction tending to prevent current from passing through the armature from the line. When the line current is cut off for any reason, the motor e. m. f. sends current through the field coil in the same direction as the previous current from the line, as indicated by the arrows in the figure at the right. (The direction of the currents from the line is shown in the figure at the left.) The motor then acts as a shunt dynamo, exciting its own field until the speed drops off.

*367. Is the motor e. m. f. of any practical importance?*

It is of great importance in the operation of the motor. Early inventors tried to get rid of it, but it was soon found that the motor e. m. f. was necessary for the efficient operation of an electric motor.

*368. Why did inventors try to get rid of motor e. m. f.?*

Because it limits the current through the motor. They reasoned that the power delivered by the motor was proportional to the current taken. But they found that the motor e. m. f. was in such a direction as to oppose the current (for which reason it is often called a "counter electromotive force," or "c. e. m. f."), and so they tried to make motors that would not develop much c. e. m. f. Such motors were found to take more current, as was expected, but they did not develop the desired power.

*369. Does Ohm's law apply to the current taken by a motor?*

It does when properly applied. The current through the armature of a shunt motor equals the difference between the line and counter electromotive forces divided by the resistance of the motor armature (including resistance of brushes and commutator). The current through the field of such a motor is simply the pressure divided by resistance.

*370. Why do motors with small c. e. m. f. develop but little power?*

Because the same elements in a motor that cause it to deliver power are also the elements causing the c. e. m. f. In fact, it is now understood that the power given out by a motor equals the product of the current by the c. e. m. f.

*371. What determines the power given out by a motor?*

The power depends upon the pressure and current supplied to the motor, the current being regulated by the amount of work put upon the motor, as will be explained. In order not to get into too great complication at first, it may be presumed that the motor has a steady load and is working properly. The work being done by the motor and the electrical energy taken from the line may then be analyzed.

*372. What elements compose the power delivered by the belt of a motor?*

The mechanical power equals the product of the speed by the pull on the belt. For example, if the belt is running at 55 ft. per second, and the pull on the belt (or rather the difference between the pulls on the tight and loose sides of the belt) is 10 lbs., the power is 550 foot-pounds per second, or 1 horse power. Making allowance for small losses in friction and in heating the iron core of the armature, the product of belt speed by pull equals the product of the pull on the armature wires multiplied by the speed at which they move. (In the case of toothed armatures, the pull comes upon the teeth more than upon the wires themselves, but the theory may be extended without great difficulty to cover that case.)

*373. What elements make up the pull on the armature wires?*

The pull on each wire (measured in dynes) equals the product of current by strength of field by length of wire in the magnetic field. The pull upon the whole armature is the product of the number of wires by the current through the armature by the effective number of magnetic lines of force through the armature divided by 3.14 times the diameter of the armature. (See also Nos. 332, 333 and 334, Amer. Elec., XI., 432, Sept., 1899.)

*374. What elements make up the velocity of the armature wires?*

The velocity equals the number of revolutions by the distance around the armature. The latter is, of course, the circumference of the armature (considering the average position of the wires) and is 3.14 times the average diameter.

*375. What elements compose the power delivered to the shaft or pulley of the motor?*

This equals the product of the pull upon the armature wires multiplied by their speed. In multiplying the factors of the two elements, as given in Nos. 372 and 373, it is seen that "3.14 times the diameter" multiplies one factor and divides the other, so that the two cancel. The final product for the work is: Armature current multiplied by number of armature wires by effective number of magnetic lines through armature by number of revolutions per second.

*376. What elements compose the counter electromotive force?*

The counter, or motor, e. m. f. equals the rate of cutting lines of force and is the product of the number of armature wires by the number of revolutions per second by the effective number of magnetic lines of force through the armature. (This gives the e. m. f. measured in the absolute or "C. G. S." unit, which is only one one-hundred-millionth part of a volt.)

*377. What is the relation between power and counter electromotive force?*

From Nos. 374 and 375 it is seen that the power equals current multiplied by the product of wires by revolutions by lines of force, which equals current by counter electromotive force. Thus it is seen that while the c. e. m. f. limits the current, it is one of the factors of the power. (In the case of alternating current motors, the power of the motor equals the product of current by the part or component of the c. e. m. f. which is in phase with current, this product being multiplied by another factor depending upon whether it is a single phase, two phase or three phase system.)

*378. For what sort of a motor does the above reasoning apply?*

For simplicity, the above has been developed only for a bi-polar direct current motor, but the argument might be modified to apply to any kind of a motor, and the general conclusion applies to any electric motor.

*379. What units were used in the above argument?*

For simplicity, the units of the metric or "C. G. S." system were used. The conclusion, however, in No. 376 is independent of the units used.

*380. What is meant by "effective magnetic lines of force"?*

In a dynamo or motor the brushes are so set, or the magnetic field is so distributed, that the e. m. f. in some of the wires is in the opposite direction to that in the rest. Sometimes this is to diminish the sparking at the brushes, or is due to incorrect design or to improper resetting of the brushes. For this reason the effective number of wires or of magnetic lines is less than the total. We may consider either that not all the wires are effective, or that not all the lines are such.

*381. Does the power delivered by a motor increase as the c. e. m. f. increases?*

The two vary inversely so long as the c. e. m. f. is more than half of the line e. m. f. This is because the current is controlled by the c. e. m. f., being equal to the difference between the line voltage and the c. e. m. f. The power equals the product of current by c. e. m. f., and it follows that the power increases as the c. e. m. f. decreases, so long as the difference between the two e. m. f.'s increase faster than the c. e. m. f. decreases.

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# Queries and Answers

Is there any difference in the horse-power that can be obtained from a gasolene engine at an elevation of 1200 ft above sea level and the power that it will give at sea level? How much will a gasolene engine that gives 35 brake horse-power at sea level lose at an elevation of 1200 ft., using the same grade of gasolene and other conditions remaining the same. O. W. J.

The power of a gasolene engine depends upon the amount by weight of explosive gases that can be gotten into its cylinders. With reduced barometric pressure this weight will be proportionally reduced, but the reduction at 1200 ft. is so slight as to be almost negligible. While the pressure of the atmosphere at sea level is 14.7 lbs. per sq in., at an altitude of 1,200 ft. it is 14 lbs., giving a difference of only about 5 per cent. A 35 h. p. gasolene engine might be expected to give fully 33 h. p. at this elevation. Such engines are generally rated with a margin of about 10 per cent. of reserve power above their rated power to cover variations in quality of fuel, etc., and they will rarely fall below their rated power, due to reduced air pressure, except at elevations of several thousand feet.

Please explain how I can excite an alternator from a 500-volt direct-current generator. H. C. L.

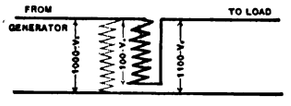
You can temporarily excite the alternator by connecting its field in series with a suitable resistance across the 500-volt mains. The field of the alternator is undoubtedly wound for 110 volts, so that you will have to absorb about 400 volts in the series resistance, i. e., it will have to have about four times the resistance of the field winding to be excited. A good temporary resistance for this purpose is a water rheostat. Of course this method is too wasteful to be kept in service. If you wish to regularly excite your alternator in this way its fields should be rewound with wire of about ¼ the present circular mils (6 numbers finer on the Brown & Sharpe gage) and 4 times the present number of turns. The winding will then have 16 times as great a resistance as at present and with about four times as great a voltage will take about ¼ the present current; thus 4 times the present number of turns will give the same ampere turns and the same excitation.

How do you find the number of circular mils in a given bar of copper such as a bus bar? F. M.

The number of circular mils in a bar of copper can be readily found if the bar is of circular cross section. In this case the number of circular mils is the square of the diameter of the bar in thousandths of an inch. For instance, the diameter of a ½ in. bar is 500/1000 and the number of circular mils is the square of 500, i. e., 500 x 500, or 250,000 mils. A 1-in. bar has a diameter of 1000/1000 and its cross section is 1000 x 1000 or 1,000,000 circular mils. The cross section in circular mils of rectangular bus bars is more difficult to determine. It is most easily calculated by remembering that one square inch is equal to about 1,720,000 circular mils. Knowing the cross section of a bar in square inches, therefore, multiply it by 1,270,000 and the result will be the cross section in circular mils.

(1) How should I connect a transformer on a 1000-volt circuit to boost the voltage? Does this effect both sides of the line or only one? (2) I am desirous of using some transformers wound for 1000 volts on a 2000-volt circuit; would it be practical to connect the primaries of two transformers (which are from one to two poles apart) in series, using single-pole fuse blocks, the secondaries connected in multiple as in the case of the 1000-volt circuit? E. B.

(1) A transformer used for boosting the pressure of a 1000-volt circuit should be connected up according to the accompanying figure, the primary being connected across the incoming circuit, one terminal of the secondary to terminal of the primary and the other terminal of the secondary to one side of the outgoing circuit, the other side of the outgoing circuit being connected to the opposite side




THE CONNECTIONS OF A TRANSFORMER FOR BOOSTING THE VOLTAGE.

of the incoming circuit and the primary. In this way the 100 volts set up in the secondary of the transformer is added to the 1000 volts, making the voltage delivered beyond the boosting arrangement 1100 volts. The best way to determine which end of the secondary to connect to the primary and which end to connect to the line is to try it one way and see whether it boosts or depresses the voltage. If the voltage is depressed the connections of the secondary should be reversed. This arrangement—although the boosting is done on one side of the line—affects the voltage between the two sides of the line so that it cannot be said to affect one side more than the other. (2) Yes, it would be practicable. The two transformers used together in this way should of course be of about the same capacity because the same primary current goes through the two in series, making the output of both the same, and if one transformer is larger than the other its useful capacity will be limited to that of the smaller.

(1) What other causes are there besides the friction of the brushes upon the commutator that cause the "humming" or "singing" of motors or dynamos? (2) How can this singing be remedied? (3) In an iron-clad armature, what effect upon the efficiency of general properties of the machine does the number of slots have? For instance, for a thirteen (13) inch armature text-books recommend about sixty (60) slots, while the writer has known armatures of this size with but thirty-five (35) slots to be very satisfactory. (4) With a given number of commutator bars or a given number of coils, what is to be recommended, a few slots with several coils per slot or a greater number of slots with fewer coils per slot, and what considerations govern the best proportions?

(1) The humming or singing is in part due to the passage of the armature teeth under the pole tips and (2) may be reduced by rounding the latter, although this course is likely to interfere somewhat with good commutation. (3) The more slots there are the less is the magnetic reluctance of the air gap and the less is the iron loss in the pole pieces if the latter are solid. The commutation is also improved by increasing the number of slots up to the number of commutator bars at least. (4) A greater number of slots with fewer coils per slot is more expensive, but preferable.

I am connected with a street railway having poor rail bonds and a heavy drop in the line. I have taken one-minute readings from end to end of the line and return, a distance of 16 miles, on both voltmeter and ammeter showing voltage ranging from 550 volts down to 250 volts and current from zero to 200 amperes. To calculate the horse power would it be correct to use 746 watts per h. p., or a larger number? Could you suggest any other useful data I could figure out from these readings beside h. p.? How about track resistance; could it be obtained? J. W. B.

I presume that the one-minute readings on voltmeter and ammeter were the readings of the voltage obtained on and the current used by a car. To calculate the horse-power absorbed by that one car the voltage at any one reading should be multiplied by the current at that same reading. The result divided by 746 will give exactly the number of electrical horse-power that that car at that instant absorbed from the line. The total amount of power required at the power house for that one car would be the number of amperes going through the car multiplied by the power-house voltage at that instant, divided by 746. Other data that would be of value to you are the drop and waste of power and the track resistance. The maximum drop, viz., that at the end of the line most distant from the power house, is the difference between the voltmeter reading at the station and that of a voltmeter located at the distant end of the line. This can be obtained by taking a voltmeter out to the end of the line and making a number of readings at certain definite times and instructing the power house attendant to read the voltmeter there at exactly the same seconds. The drop will be the difference between the two voltmeter readings. This maximum drop, if the feeders are fairly uniformly loaded, will be twice the average drop. If the maximum drop is 275 volts, the pressure at the power house being 550 volts, 50 per cent. of the power sent to the end of the line is wasted, and if the average drop is half of this 25 per cent. of the power sent to all the cars is wasted in line and track resistance. If the amount of the drop in the line can be figured from its resistance and the current flowing in it an idea of the drop in the track circuit can be obtained by substracting the drop in the line from the total found by voltmeters as above.

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## THE STANDARD AUTOMATIC GAS ENGINE.

Many electrical engineers have an idea, born of sad experience, that the gas engine is inherently unsuitable for the driving of dynamos—at least with rapidly varying loads. At an earlier stage of electrical development, when the steam engines had been used for this purpose no more than has the gas engine at the present day, the average steam engine was fully as deficient in the qualities of steady and economical operation over a wide range of loads. The tremendous possible field of application of a prime mover as economical of space, first cost, attendance and fuel, as is the internal-combustion engine, compared with the steam engine and boiler, has concentrated effort, time and money on the cure of the failings of the gas engine, and this concentration is now bringing forth new gas engines as perfect for electrical service as are the steam engines developed a few years in advance of them.

One of these engines is that with the name which heads this article, and built by the Standard Automatic Gas Engine Company of Oil City, Pa. While the company is comparatively unknown as yet to the majority of present or prospective gas engine users, and while many of the details of the engine as described below are radically novel, the fact that neither the company nor the engine is in inexperienced hands is proven by mentioning the name of the president of the one and the designer of the other, Mr. J. W. Raymond, designer of the improved Raymond engine built for many years by the J. I. Case Threshing Machine Company.

The engine operates upon the familiar Beau de Rochas, or four-stroke cycle, commonly known as the Otto, giving per single-ended cylinder one impulse during two

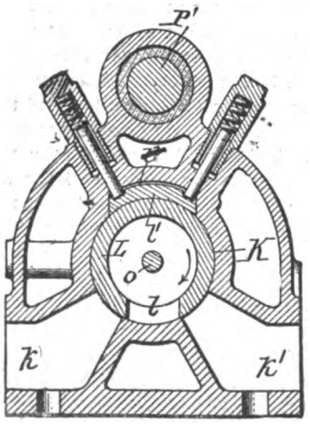



FIG. 1.—CROSS SECTION OF VALVE.

revolutions. The special features deserving, perhaps, first mention, are the valve and valve gear. There is only one valve for both admission and exhaust, and this valve is a hollow cylinder of cast-iron, chilled and ground. The interior of the valve is open to the engine cylinder and as the valve turns in the valve chest, an opening in the valve alternately connects the cylinder with an admission and an exhaust port. A cross section through this valve is shown in Fig. 1. L is the cylindrical valve rotating in the valve chest, K, and held up against the valve seat by the springs and piece, l'. As it rotates, the port, l, connects the interior of the valve—which is open to the cylinder—alternately with the admission chamber, k, and the exhaust chamber, k'. The valve does not oscillate or have a reciprocating motion of any kind, but simply rolls continuously around in one direction, being turned by a horizontal shaft, driven by mitre gears from the main shaft, and turning the valve stem by 2 to 1 spur gears. The absence of poppet valves, cams, springs, and so forth, makes the engine remarkably noiseless.

The ignition is electrical in character, accomplished by a wiping spark between wide tool-steel electrodes. The moving contact simply rotates with the valve, and the stationary contact is held by springs outside the valve chest and adjustable while the engine is in operation.

The governing of this engine is not accomplished by missing impulses, but by varying the quantity of the charge by throttling. The mixture is throttled by one plain balanced butterfly valve as simple as the damper in a stove pipe and almost entirely free from friction, since all points of the butterfly, except the stem, are out of contact with the walls of the valve chamber except when the valve is shut tight. For this reason the force which the governor must apply to move the valve is much less than that required for piston or other forms of valves, the leverage and necessary extent of motion of the fly balls is reduced and the regulation is correspondingly perfect. The proportions of the mixture are determined by entirely independent valves in the incoming air and gas pipes, the constituents being pulled through these and the mixture being pulled through the governing valve by the suction of the filling stroke.

The engine is horizontal and in small sizes, 15 h. p. and upward, is of the ordinary single-acting form, with a trunk piston acting as a cross-head. In sizes of 50 h. p. and up, the engine is made with two single-acting cylinders tandem on the same piston rod. The cycles of the two cylinders are displaced one revolution from each other, so that one impulse per revolution is obtained, the expansion stroke in one cylinder occurring immediately before the compression stroke in the other.

Naturally, some means must be devised for cooling the piston rod, which runs out through the explosion chamber of the cylinder nearer the crank to the piston of the other cylinder. The piston rod is extended out through the head of this cylinder also, in the form of a tail rod, and is made hollow. A long pipe is then inserted into the hollow rod and is packed at the tail rod end. Cooling water is injected through this long pipe clear into the rod in the second cylinder and flows back inside the rod, but outside the pipe, to a drip at the tail rod end. The piston rod is packed with non-inflammable packing where it comes through the cylinder head.

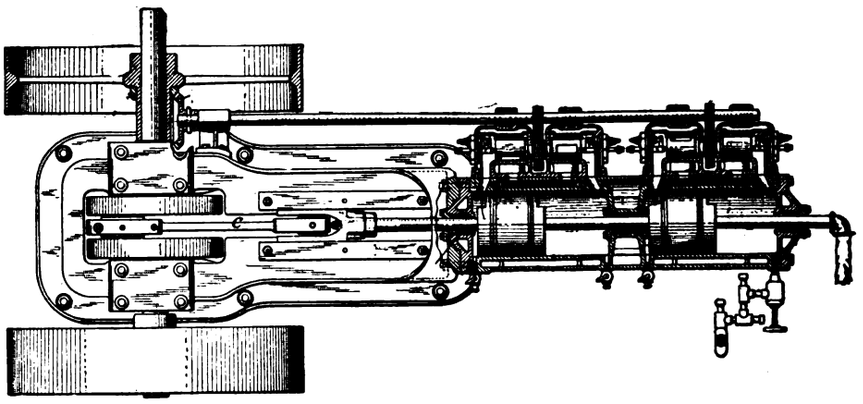


FIG. 2.—PLAN OF TWO-CYLINDER DOUBLE-ACTING ENGINE.

The company has recently completed a still more interesting engine with two 18-inchx18-inch double-acting cylinders, tandem on one piston rod, with outside cross-head of standard steam engine construction. The two double-acting cylinders give two forward impulses per revolution simultaneous with the compression strokes in the other end of the cylinders. The heavy compression both ways gives very smooth running, even with considerable slack in the cross-head and crank-pin boxes. The piston rod of this engine, owing to the heavy strains it is called upon to bear, is made of nickel steel, drawn with the hole for the cooling water in it. The water in this case is introduced through the cross-head and discharged through the tail rod. One balanced-pressure sight-feed lubricator on the center of each cylinder lubricates the pistons with a high fire-test engine oil. Fig. 2 shows a plan of this engine.

The pistons are cored out and the water passing through the rod is compelled to circulate also inside the pistons, thus cooling them. One horizontal shaft runs along beside the cylinders and turns the four valves of this engine (one for each end of each cylinder) through two pairs of cut gears. The governor actuates one butterfly valve, which throttles the mixture to

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all four cylinder ends. The course of the mixture to any one, two or three of the four cylinder ends may be cut off to increase the compression and economy at low loads. Indeed, any valve chest may be opened and the igniter taken out while the engine is running.

This engine is started by turning it over to the proper point and igniting electrically a charge of very slow burning powder in an enclosure connected with one cylinder head. The connection is made through a number of right-angle bends made in capped tees in such a way that the ash from the powder blows past the bends and is caught in the caps, from which it may be removed from time to time. The engine may also be piped to a compressed air tank or steam supply for starting.

This engine is shown in Fig. 3 set up and belted to a 150-kw. Westinghouse generator for the Oil City Street Railway. A duplicate is under way for the same purpose, and two of 500 h. p. each are under order. No storage batteries will be used.

The engines are rated on the basis of mean effective pressure, the one shown in the illustration being conservatively rated at 200 h. p. on the basis of a mean effective of 32 pounds per square inch, although much higher mean effectives may be obtained. Indeed, this engine is guaranteed to develop 300 brake h. p. with a consumption of not more than 3000 cubic feet of natural gas per hour, this gas showing about 990 B. T. U. per cubic foot.

An interesting equipment of engines for which the company has closed a contract will consist of four like that shown in the illustration, which are ordered for use in Germany. These will be made into two engines by coupling two of them together with cranks at quarters, each complete engine thus consisting of two pairs of tandem double-acting cylinders giving four impulses per revolution. Each such engine will be direct coupled to a three-phase 60-cycle alternator mounted between the cranks, and these alternators will be run in parallel and with rotary converters. Another order is for two engines of 350 h. p. each, to carry a street railway load in western Pennsylvania. These engines will get their gas from by-product coke ovens, a gas which is at present thrown away, and will require no elaborate preparation such as washing or scrubbing to adapt it for use in the engines. All it needs is to be passed through holders in which it can deposit its tar.

The Standard Automatic Gas Engine Company, of which Mr. Raymond is President, as noted above, is capitalized at $36,000, but expects to increase its capitalization to $100,000 to accommodate increasing business. It has recently erected new shops on the bank of the Allegheny River, about two miles below Oil City. The building contains also the new street railway gas engine power house and is about 180 feet long by 67 feet wide. The contract will soon be let to lengthen it 150 feet.

## A NEW WORKS FOR MAKING HIGH-WOUND MAGNET COILS.

The apparent paradox is often observed that the simpler an article of manufacture the more complicated is the machine designed to produce it. This is due to the fact that the very simple products are made in enormous quantities, and are turned out complete by automatic machines much more complicated than any tools used in the handiwork of more elaborate products. An interesting example of this is one of the simplest operations in the electrical arts, that of winding fine magnet coils. The work carried out on a very large scale involves automatic machinery, resembling that of textile establishments. An interesting instance of such an equipment is contained in a new building which the Varley Duplex Magnet Company has recently completed in Jersey City to accommodate its constantly increasing demands. A description of this new plant and the peculiar process of magnet winding brought to such a high stage of perfection by this company may be of interest in connection with the commencement of work in the new quarters.

The new works consist of a five-story building 50x25 ft. in plan, which is unique in that it is constructed almost entirely of concrete with an extremely small amount of either wood or iron. This construction was adopted to give an absolute protection against fire for the elaborate automatic machines described below. The concrete structure was built just as is a concrete dam, i. e., by means of knock-down frame forms or moulds, between which the mass is thrown and tamped. The floors, which are designed to carry 800 lbs. per square foot, are of concrete integral with concrete beams and cross-beams. The beams are of an inverted T section, the downwardly hanging head of the T serving for a convenient support of shafting or other apparatus in the room below.

While at present the company has a capacity of some 8000 standard telephone bridging bell magnets of 10,000 turns each per diem, the full capacity of the new works when the machinery is entirely installed will be 20,000 such magnets. The company has given up all branches of magnet making except the mere winding of the coils, for which the president of the company, Mr. R. Varley, and his engineers have designed some extremely ingenious automatic machines, a description of the operation of which may be given as follows:

As the users of the Varley duplex magnets know, the magnet wire itself is not wrapped with an insulating cover but the insulation of the wires of each layer from each other is accomplished by means of a silk thread wound between the bare copper turns, while the insulation of the layers from each other is accomplished by means of a thin sheet of paper inserted

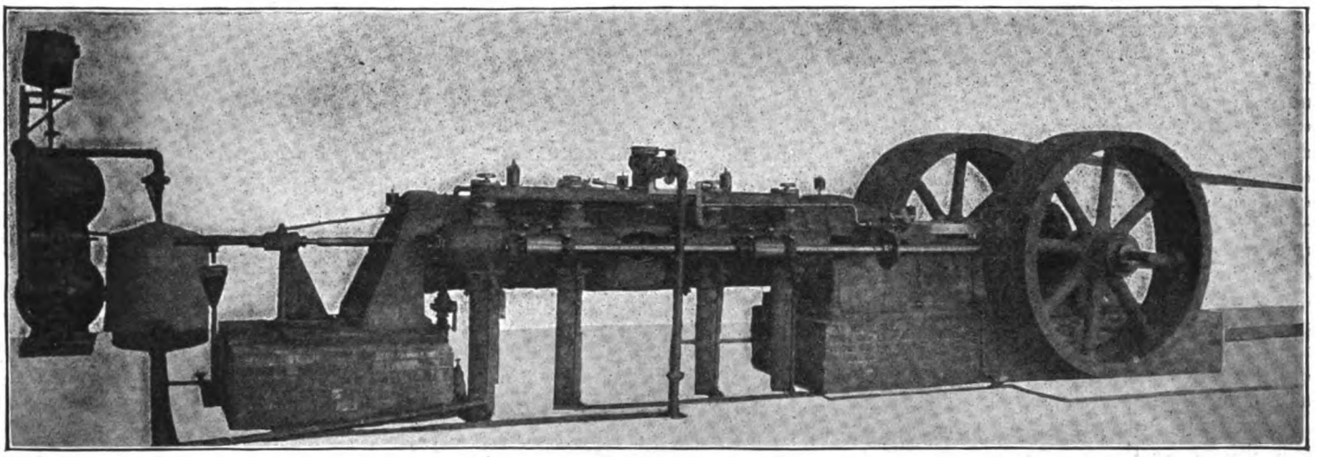
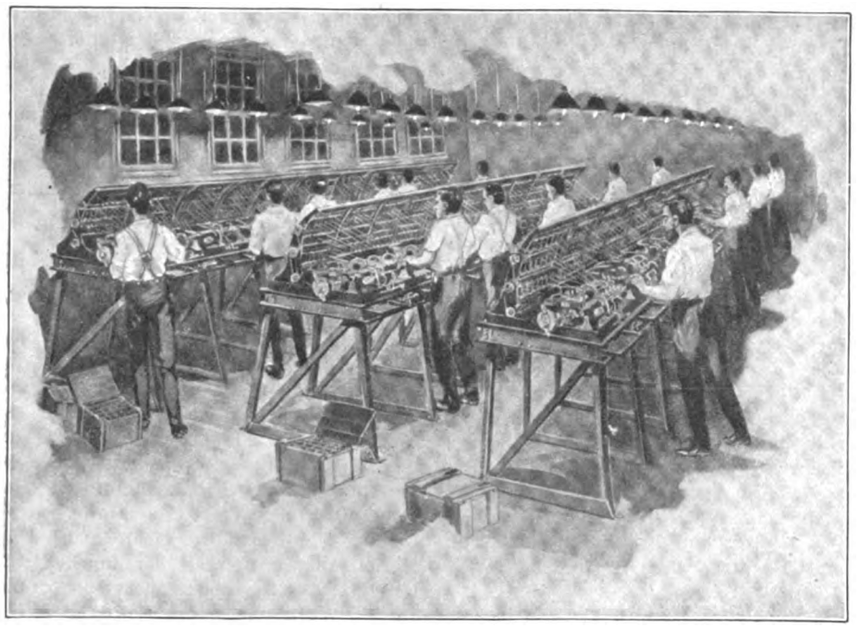


FIG. 3.—VIEW OF 300-H. P. ENGINE AT WORK ON RAILWAY LOAD.

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A VIEW OF SEVERAL VARLEY MULTIPLE AUTOMATIC WINDING MACHINES, EACH CAPABLE OF WINDING OVER 10,000,000 TURNS OF WIRE PER DAY.

after the winding of each copper wire and silk thread layer is finished. Each machine that makes these coils does not simply wind one coil at a time, but winds a tube of coils with a length of one foot, which may be divided up into as many as 12 coils. If the coils are 2 inches in length, six of them may be wound simultaneously; if 1½ inches, eight may be wound, etc. For this reason the winding apparatus is termed a "multiple" machine. The older machines simply wound on the copper and silk, depending on the operator to slip in the sheets of paper at the proper intervals. The new machines, called "multiple automatics," insert sheets of paper between the layers without attendance on the part of the operators, the strip of paper being automatically cut off each time a little wider than before, so as to cover the increased diameter.

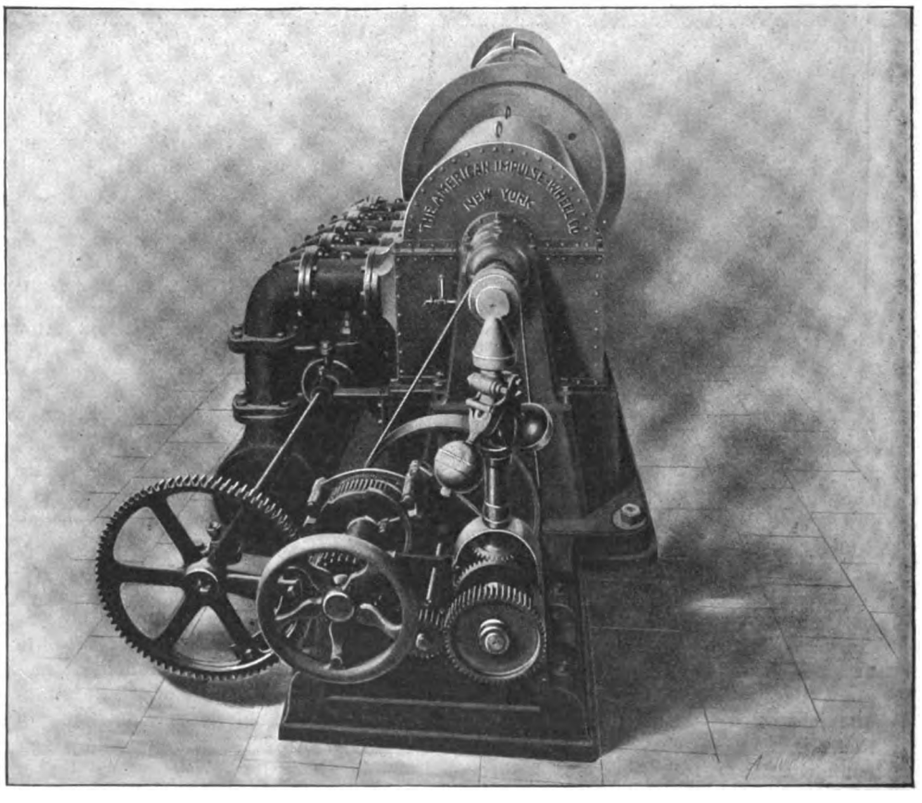
The next operation after the coils are wound is to saw them apart. A considerable space of paper is left without wire between adjacent coils on the rod so that when they are sawed apart, the ends of the layers cannot escape from the paper and unravel. The inner end of the wire is then fished out by means of a crochet needle and both ends are stranded with a tinned copper wire to give strength, stiffness and ease of soldering. The whole coil is then wrapped in a paper jacket with fringed ends, which are folded down over the ends of the coil and the latter is ready for shipment.

Each of the new automatic machines is capable of winding 1200 to 1500 coils per day with 10,000 turns each. An idea of what this means can be gained from the fact that an operator can only wind about 60 such coils per day by hand. One of the winding machines will consume 500 lbs. of No. 36 wire per day, while a wire-covering machine will only cover about one pound per day per head. The company now has 14 of these multiple automatic winding machines, and has 30 more under way.

The automatic winding machines are very accurate in that, provided the gage of the wire remains uniform, the resistance of coils turned out does not vary more than one-fourth of one per cent; one-half of one per cent is guaranteed when wanted.

A few facts concerning the raw materials used may be of interest. The greater part of the company's work consists of telephone drop and other coils of high resistance for modern bridging systems. These coils are wound with a copper wire running down as fine as .003 of an inch in diameter, which is somewhat finer than No. 40 B. & S. gage. With copper running from No. 36 to the finest gage used, the silk thread runs 120 miles to the pound. This thread contains much less silk than would be required to wrap each individual turn, so that the total cost of the coil complete is less than the cost of single-covered silk wire of equivalent length required for a similar coil. The paper used is imported parchment, .0008 inch in thickness, stiff, tough and strong, and with considerable insulation resistance. The use of this material allows, it is claimed, from 4 to 16 per cent more turns to be wound into the same space as would be occupied by a single-covered silk wire of the same gage. The strips of paper take out any little irregularities and prevent any turn of the wire, especially those on the end of the layers, from working down past the other layers and coming into the neighborhood of turns with a considerably different potential. This adapts the winding to high-tension work, such as that of induction coils.

The company not only does the winding, but makes also its own winding machines in a machine shop in the same building. It also covers its own wire for use on



A STEAM-DRIVEN WATER-POWER ELECTRIC PLANT. VIEW OF GOVERNOR.

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induction coils. The company has also been compelled, in order to get uniform gage, to draw its own copper. It has a drawing plant at Belleville, N. J., which now turns out 1500 lbs. per week of No. 35 wire. Eight thousand pounds of wire of various sizes are also absorbed per week from other sources. The number of employees at present is 128, and the machines run five nights per week.

## A STEAM-DRIVEN WATER-POWER ELECTRIC PLANT.

There is at present in operation in the pumping station of the City of Columbus, Ohio, a lighting plant which is unique in character, and which presents a number of interesting engineering features.

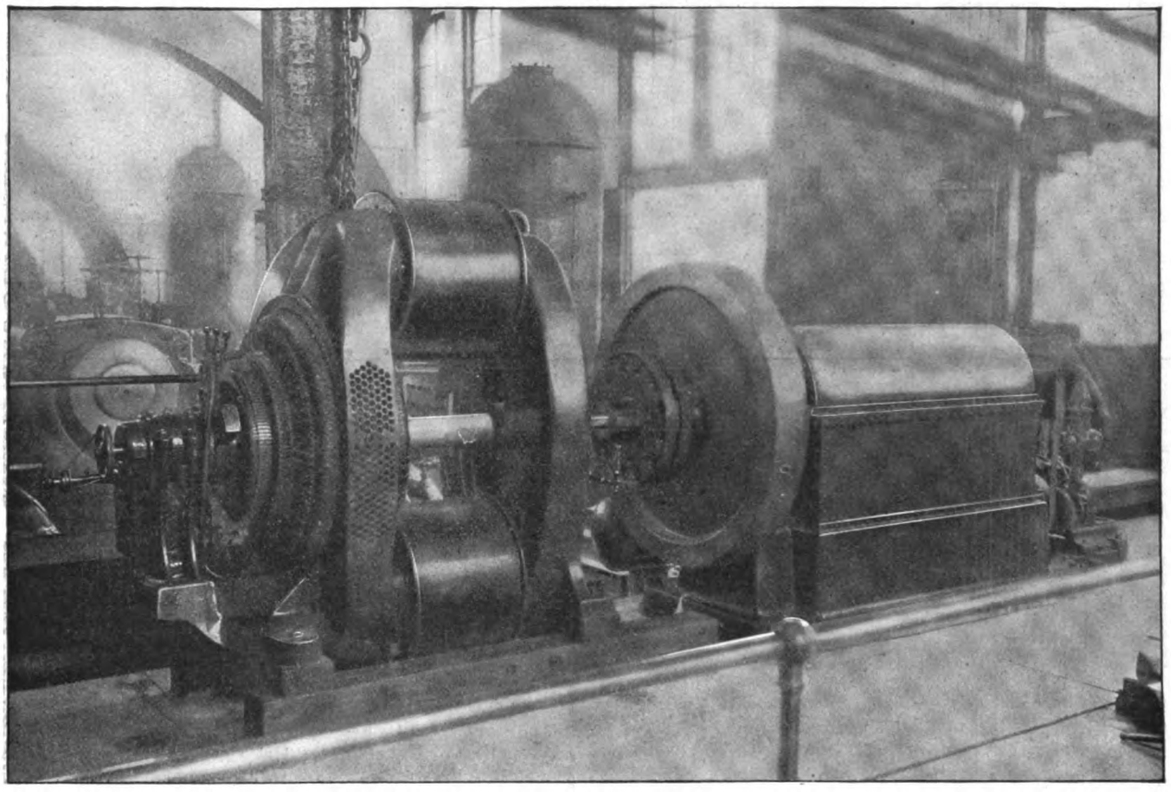
The Director of Public Improvements, finding that the pumping capacity of the station was greater than required, looked about for some means of utilizing the surplus capacity, and hit upon the idea of using the surplus water that the pumps were capable of supplying, to drive water wheels direct coupled to series arc dynamos.

The specifications were very rigid in their requirements with regard to both efficiency at all loads and to speed governing under sudden and great changes of load. The difficulty of the problem was also enhanced by reason of the very limited space available for the machines and piping, and by the high speed required for direct connection to the Western Electric Company's 100-light arc dynamo, which was the machine selected by the engineer in charge. This speed, 650 r. p. m., necessitated the use of impulse wheels only 18 inches in diameter, and in order to obtain 110 h. p. from each unit 18 nozzles were required. These were arranged with 6 runners, 3 nozzles to each runner, since a larger number of nozzles per runner would have reduced the efficiency below the guarantee.

The use of contracting nozzles to keep up the efficiency at light loads was prohibited by the great cost and complication of so large a number of contracting nozzles. Ordinary butterfly valves were accordingly used with the cam mechanism for operating these valves shown on the last page, arranged to actuate them one after the other, instead of all together, as had previously been common practice. As a result of this arrangement, all the valves in operation, except one, would be wide open and working, therefore, at their maximum efficiency, and thus the low efficiency of a partly closed butterfly valve would have an almost inappreciable effect in lowering the total jet efficiency of the machine, and at six values of the load, when a valve had just completely closed, would have no such effect at all.

The rigid requirements with regard to efficiency having been thus complied with, the problem of speed governing was next attacked. The small diameter of the runners, rendered necessary by the high speed so far reduced their momentum that it was necessary to add a heavy fly wheel in order to keep the variations of speed within the guaranteed limits. The high speed also prohibited the use of the ordinary cast-iron fly wheel. The wheel was accordingly made with a steel rim shrunk on to a cast-iron web. The governor is the ordinary mechanical relay actuating six cams as shown in the illustration on the opposite page, the connection between the cam shaft and the governor being by gear and pinion.

The water chambers were cast in two pieces, as shown below, the nozzles being bolted on so as to come in exactly the right position with reference to the runners. This large casting rested on the cast-iron base and was bolted to it. The casing was made of riveted boiler iron in two parts, the upper half being provided with eyebolts for lifting. The details of the piping, receiver, etc., are clearly enough shown in the accompanying illustrations.



IMPULSE WHEELS DIRECT COUPLED TO ARC MACHINE AT THE WATER WORKS PUMPING STATION OF COLUMBUS, OHIO.

The fact that this plant has now been running for over 12 months without trouble and to the satisfaction of the engineer in charge, reflects credit upon the American Impulse Water Wheel Company, which was the builder and contractor, as well as upon this company's consulting engineer, Mr. Thorburn Reid, to whom was entrusted the task of meeting the difficulties presented by this new departure in water-wheel engineering.

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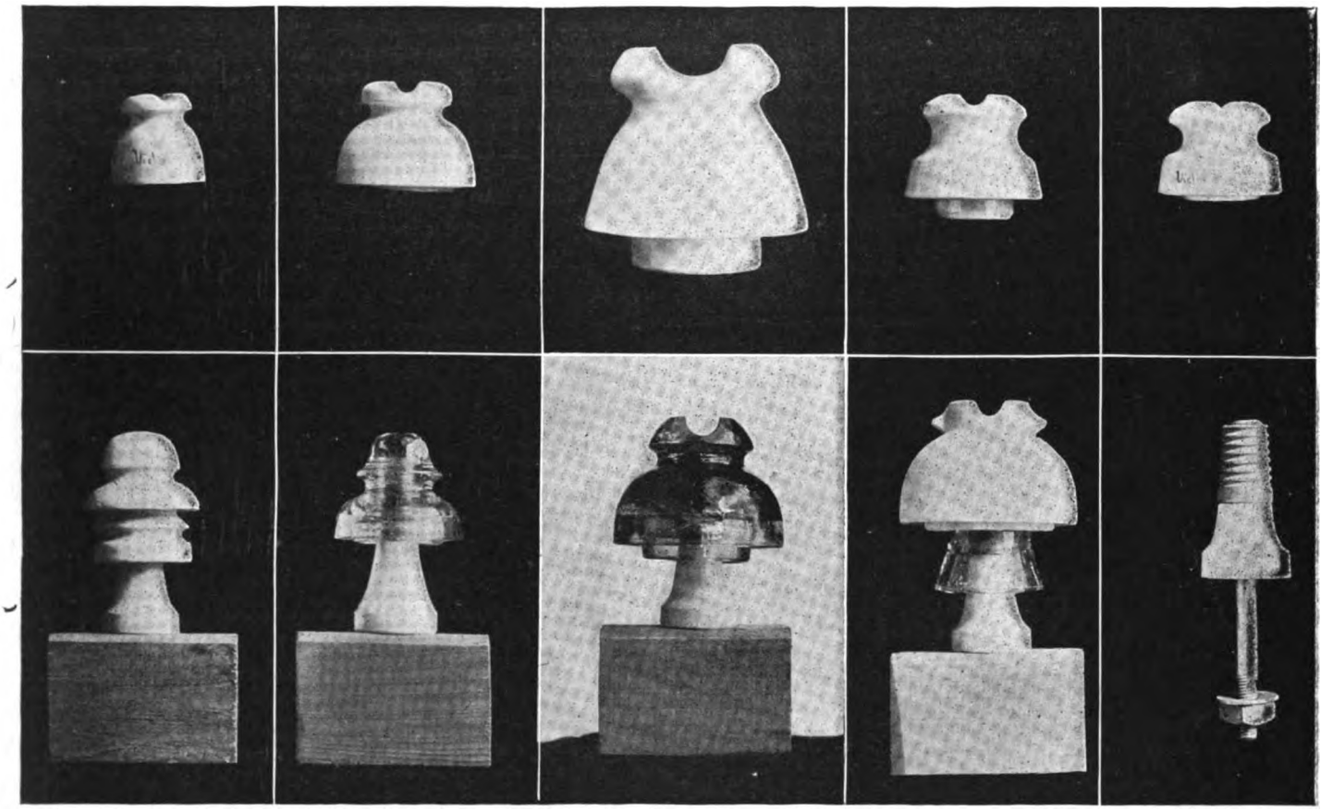
# New Apparatus and Appliances

### LOCKE INSULATORS.

In the manufacture of insulators for very high voltages the material used must not only have a very high specific resistance and dielectric strength to resist the tendency of the current to break through it, but it must interpose a large creeping distance to prevent the current traveling over it and must provide a considerable gap between the edge of the bell and the pin to prevent the current sparking across from the wet exterior to the pin and charring and setting fire to the latter. These various considerations, combined with the peculiarities of china, porcelain and glass making, constitute the construction of insulators a fine art. The ways in which some of the difficulties of the problem have been overcome by one maker are illustrated by the accompanying reproductions, Fig. 1, of several styles of insulators made by Mr. Fred M. Locke, Victor, N. Y.

In the first place the insulator, when used for heavy work, at least, is mounted on a steel pin such as is shown in the lower right-hand corner of the illustration, and the upper part of this pin is capped with wood to prevent the breakage of the insulator through the difference between the expansion of iron and the material used in the bell. Below the wood is a porcelain sleeve which surrounds the pin and rests upon the top of the cross arm. This porcelain acts as a protection against sparking from the shell of the insulator to the pin and greatly increases the sparking voltage. The use of this pin may be seen in the other illustrations of the lower row. That to the extreme left is a transposition insulator, while to the right of it are shown porcelain and glass insulators for various voltages.

In the upper row are shown various forms for street railway use. Some of these are made in two parts, which are burned together in the second heat when the glaze is put on. This gives an extra resisting wall, which must be broken down before the current can leak through, besides which this form of construction makes each part of a more uniform thickness during the first heat, when the different rates of shrinkage of parts of different thicknesses would tend seriously to set up serious initial strains which would greatly weaken the resisting powers of the insulators to the strains of service.



Pony porcelain insulator with one petticoat for telephone lines. | Pony double-petticoat china insulator. | Street Railway top groove cable insulator, two parts. | Street Railway porcelain insulator side groove for standard pin. | Street Railway cable china insulator for heavy work.

Porcelain transposition insulator. | Glass insulator for 5,000-volt lines. | Glass insulator for 20,000-volt lines. | Porcelain and glass insulators for 25,000-volt lines. | Pin for street railway and heavy line work.

FIG. 1.—VIEWS OF VARIOUS FORMS OF LOCKE INSULATORS.

### THE PULLEN BATTERY.

Not to be outdone by its younger brother the dry battery which has recently been adapted to recharging, and consequently to storage work, the wet battery has been improved in the same way.

In the Pullen cell, which enjoys this distinction, the electrolyte is 10% sulphuric acid and the positive electrode is carbon in the form of a cylindrical rod like an ordinary arc light carbon. This is surrounded by a thick layer of a black mass, which is used as a depolarizer, but which differs from that used in the usual Leclanche or the dry cells. The negative electrode is a zinc cylinder surrounding the carbon electrode.

The strong activity of the depolarizer was shown to us by the inventor in an interesting experiment. He made an improvised cell by touching the end of a carbon and zinc rod, each ½ inch in diameter, to the opposite sides of a cloth saturated with dilute sulphuric acid and closed the circuit by an electric bell; the action was too weak to ring the bell, but as soon as he added a little of the depolarizer between the carbon rod and the cloth the bell began to ring at once and did not stop until the sulphuric acid was consumed; the formation of sulphate of zinc could be seen. If, then, some fresh elec-

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trolyte was added, the bell began to ring again.

The e. m. f. of the Pullen cell at open circuit is given at 2.2 volts, and the internal resistance is said to be very small. The cell can be used to advantage for electric bells, fans and all such purposes, just as can other primary cells. The main point of interest, however, is that it is said to compete successfully with accumulators in automobile traction. The inventor states that the cell may be discharged at a very high rate without being injured and that it can be recharged again by simply connecting it with the mains of an electric station, in the same way as is done with accumulator batteries. The inventor points out that no lead at all is used in his cell, and that it is therefore possible to construct it exceedingly light compared with lead accumulators; so that his cell has the advantage of the accumulator batteries for driving automobiles, without the disadvantage of the heavy weight of the latter.

The complete weight of a battery of 44 Pullen cells, ready for use on automobiles, is given at 300 lbs.; this is said to be sufficient to drive an automobile with two people over 35 miles with one charge, the complete weight of the automobile with the battery, but without passengers, being 1100 lbs. A crude test of one of the very small cells, weighing complete in a glass jar 16 oz., is said to show a pressure on open circuit of 2.04 volts and a current on short circuit as much as 15½ amperes, which after about 20 minutes of short circuit fell to 1½ amperes. This is an exceptionally large current for such a small cell. The energy to be obtained from a Pullen battery is shown by the statement that one h.p. hour is available for every 50 lbs. of complete battery, if discharged in 6 hours.




FIG. 3.—A PULLEN CELL.

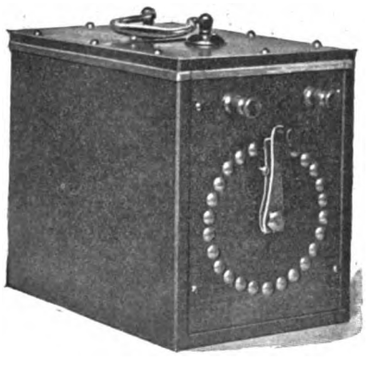


FIG. 4.—A CAUTERY OUTFIT OF PULLEN BATTERIES.

The Pullen Battery & Electrical Manufacturing Company, Philadelphia, was incorporated in 1897, to exploit the patents of Leon W. Pullen. The officers of the company are Dr. Wm. A. Davis, President; Louis W. Pullen, Vice-President; J. Madison Pullen, Secretary; Dr. S. Lewis Ziegler, Treasurer. The board of directors consists of the above named, together with Jas. F. Davis and Albert E. Bainbridge.

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### A MARINE GENERATING SET TYPICAL OF RECENT DEVELOPMENTS.

The requirements of marine work are most difficult to fill. Not only is space economized to the last degree but into this curtailed space must be built a machine which will have unusual capacity when speed and weight are considered.

The combination illustrated in Fig. 5 consists of a Bullock Type "N-I" generator direct connected to a Forbes marine engine.

The engine cylinder is 5 ins. x 5 ins., and is made for the high pressure of modern marine practice. The cylinder is supported upon three hollow steel legs which are rigidly fastened to a subbase common to both engine and generator. To two of these supports the cross-head guide is securely bolted. Means are provided to adjust for wear of the cross-head shoe and guide and in the main bearings. A perfect system of sight-feed lubricators is installed upon the side of the cylinder with copper tubes leading to all of the wearing surfaces of the engine.

A small balance wheel is provided and assists in the regulation of the engine speed. The governor, which is installed on the outer end of the shaft, is of the inertia-centrifugal type and maintains a speed between no load and all load limits of less than two per cent variation. The valve is of the cylindrical balanced type and gives a perfect steam distribution.

The generator, like the engine, is very compact, pleasing in outline and presents some excellent features of mechanical and electrical design as will be seen by consulting the sectional engraving, Fig. 6.

The yoke is a steel casting of the conventional circular form having inwardly projecting pole pieces of laminated soft steel. Each pole is bolted to the frame by two bolts, A-A, the centrally located rivet, B, of the laminated pole, C, being tapped and serving as a nut for the bolts.

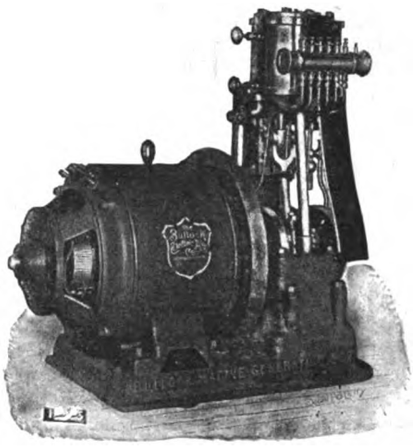


FIG. 5.—BULLOCK MARINE GENERATING SET.

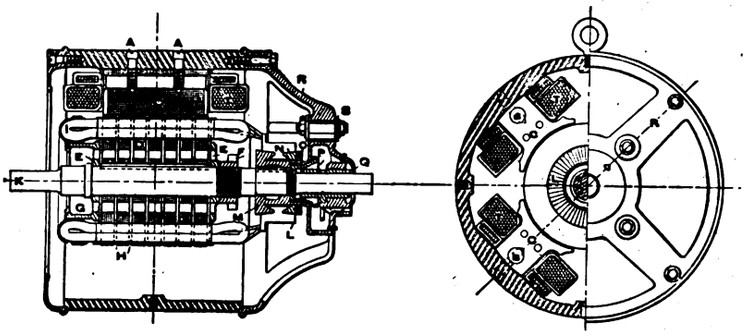


FIG. 6.—SECTIONS OF BULLOCK MARINE GENERATOR.

The armature core, D, is built up of laminated soft steel mounted directly upon the shaft and held firmly together by iron end plates, E, and nuts, F, as shown, one end plate resting against the shoulder, G. Ventilating slots, H, perpendicular to the shaft, provide a perfect means of ventilation. The windings, I, are machine formed and hot pressed and are highly insulated before being placed in the slots of the core. The windings are held in place by steel wire bands wound in slots, making a flush finish with the outside of the laminated core. The armature shaft rests in a phosphor-bronze bearing of liberal dimensions at the outer end and is key-seated in the hub of the engine flywheel, which is of extra width and provided for receiving the end, K. The commutator bars, shown at L, are held together by sleeve, M, ring, N, and nut, O. Oil shield, P, prevents oil from finding its way from bearing, Q, into the armature.

The bearing, Q, is of the self-oiling type, as shown. The end housing, R, securely bolted to the frame, carries the

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brush studs, S. The field coils, T, are machine wound and thoroughly insulated, and are slipped over the poles before the latter are bolted in position.

The engine operates at 600 r. p. m. and at this speed the capacity of the generator is 5 kw. at 115 volts pressure.

This particular set is now installed upon the steamer "Aberdeen," a vessel recently built for the Pacific coast trade.

The manufacturers, the Bullock Electric Manufacturing Co., Cincinnati, Ohio, will be pleased to send Bulletin No. 0434 showing other engine type generators, to those requesting it.

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THE LUNDELL SPLIT-POLE DYNAMO.

Several designs of dynamos have been brought out on the American market in which special provision has been made to automatically overcome the armature cross-magnetization and thus prevent the armature from distorting the fields and shifting the plane of commutation under load to a position different from that under no load. In most dynamos, however, no special provision is made, and the effect is only minimized by saturating the poles and providing a wide air gap, both of which features increase the cost and reduce slightly the efficiency of the machine. In a machine recently put on the market by the Sprague Electric Company, New York City, there is embodied an original and elegant design of Mr. Robert Lundell for overcoming this difficulty. In this design the field distortion is automatically corrected by means of the usual series coil and a very simple modification of the usual form of pole piece. The principle of its operation may be explained by reference to Fig. 7, which is a diagrammatic cross-section of a machine built on what is known as the "split-pole principle."

A is the armature rotating as shown by the arrow, and the field is, as usual, fitted with laminated poles bolted to the yokes. The polar laminations carry one wide projecting horn on the side toward which the armature rotates, and are slotted down the middle almost to the air gap. The purpose and result of this construction are as follows: When the machine is running under no load its magnetic circuit is excited to a density very near saturation. Under this condition the section, b, of the pole to one side of the deep slot is magnetized to a greater density than the section, a, at the other side of the slot, since the reluctance through the path, b, is less, due to the greater area of the air gap across which the lines through this section, b, must pass. At no load, therefore, the section, b, is practically saturated, while a is considerably below saturation. As the load increases the ampere turns, due to the series coils on the compound-wound field, increase the excitation of the whole field. This increased force drives more lines through the field circuit, but b being already saturated and a unsaturated, these lines take the latter path; thus the increase of magnetism, due to increased load, is forced over to the left, where it counteracts the general shifting of the polar magnetism to the right caused by the armature distortion.

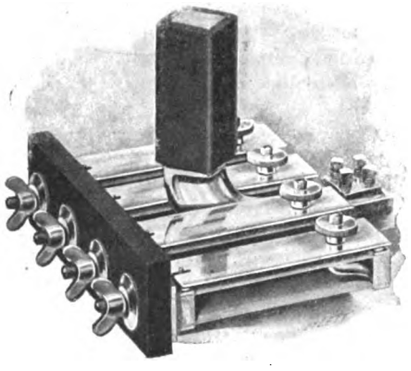


FIG. 8.—DETAIL OF BRUSH HOLDER

It is thus clear that the method is due solely to the increase of the field strength with increased load and is, therefore, dependent upon over compounding.

Another interesting detail of the same machines is the brush holder, a view of which is shown in Fig. 8. The brushes are carbon and are clamped to holders mounted on parallel motion springs through which current is carried to the cross connections. The arrangement utilizes the whole surface of the commutator, since the carbons butt against each other. This gives a better distributed wear upon the surface of the commutator and prevents the development of ridges. The clamps are made light to prevent jumping of the carbons. The parallel motion maintains parallelism between the face of the carbons and that of the commutator if the latter rises and falls, and the arrangement is such that the machines will run in one direction as well as the other.

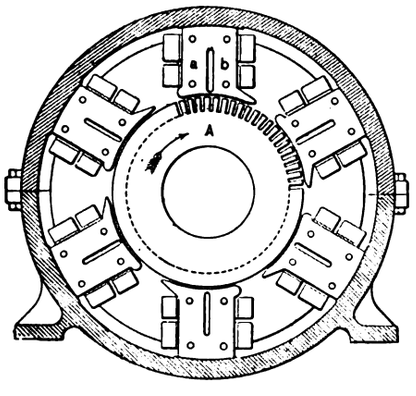



FIG. 7.—CROSS SECTION OF SPLIT-POLE DYNAMO.

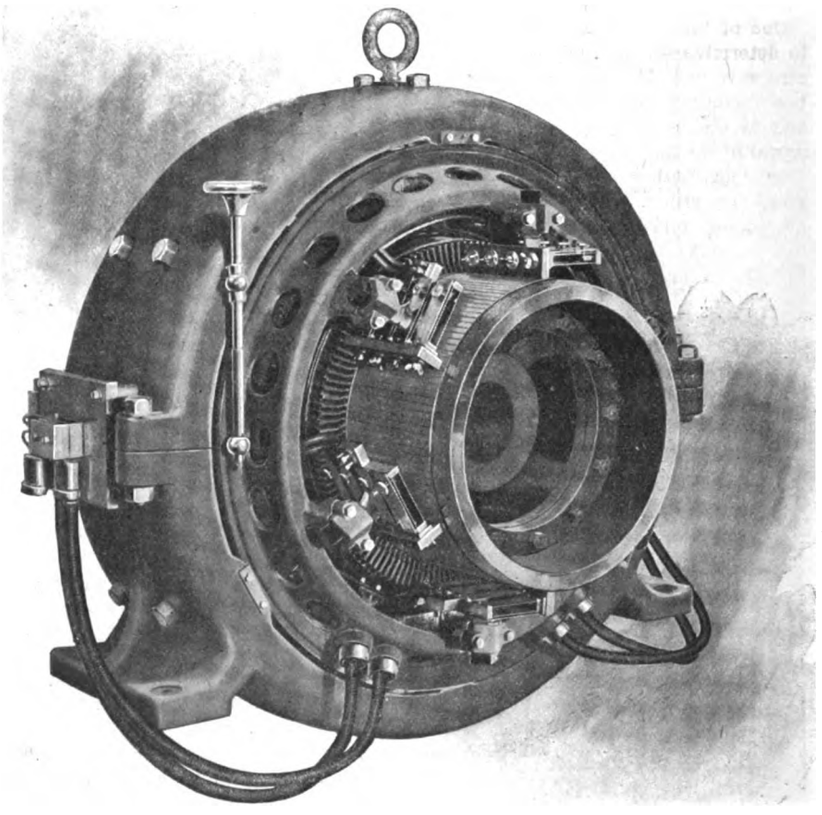


FIG. 9.—ENGINE TYPE SPLIT-POLE LUNDELL GENERATOR, 100 KW., 125 VOLTS, 260 R. P.

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### A LEAD ZINC STORAGE BATTERY.

The use of dynamo currents is becoming so general that a convenient form of small storage cell could often be, with advantage, used in place of Leclanche or dry cells commonly used for open circuit work. This storage cell could be connected in series with incandescent lamps for occasionally recharging, which would cost much less than the replacement of dry cells when discharged, or the renewal of the zinc or salammoniac of the ordinary wet battery. The United States Battery Company, New York City, puts on the market a type of cell particularly adapted for such use, the appearance of which is indicated in Fig. 10.

This is a lead zinc cell using dilute sulphuric acid as the electrolyte, the acid forming sulphate of zinc and depositing lead during discharge and forming sulphate of lead and depositing zinc during charge. An idea of the capacity of this battery can be gained from the fact that the cell shown, which is three inches in diameter by five inches in height, and weighs two pounds, has a capacity of 10 ampere hours at a half ampere discharge rate and a safe maximum discharge rate of one ampere. Its pressure on open circuits is 2½ volts, and on closed 2.35 volts.

One of these cells has been under test to determine its life and the necessity of renewals, and the company claims it has been charged and discharged 38 times and is still in service without any renewal of the materials or electrolyte.

In construction the cell consists of a glass jar with a sheet of zinc bent into cylindrical form immediately inside the




FIG. 10.—A LEAD ZINC CELL.

glass and a central lead electrode. The top is provided with a vent for escaping gases. The new form which the company is about to put on the market is made with a removable top and uncovered glass so that the appearance of the inside can be seen and the condition of the cell indicated at all times.

The battery is carried in stock with the liquid separated from the electrodes, so that there is no deterioration on the shelf.

### A TOY AUTOMOBILE.

Realizing that the present popularity of automobiles would extend to the children the Knapp Electrical & Novelty Company, New York City, has put on the market a miniature automobile for the Christmas trade in toys. The small machine weighs boxed 10 lbs., and is about 1 ft. in length and 6 ins. wide by 7 ins. high. It is driven by two dry cells, 6x2½ ins. in size, slipped under the dos-a-dos seats. The motor drives the rear wheels through double reduction gears. The battery will drive the

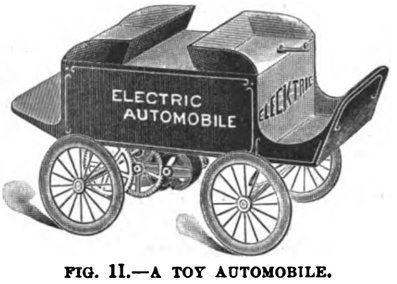



FIG. 11.—A TOY AUTOMOBILE.

wagon continuously about five hours, and if used intermittently, from 15 to 20 hours.

### AN ANNUNCIATOR MECHANISM.

In the design and construction of annunciators the prices which can be realized necessitate that all metal parts shall be simple punchings or stampings and that they be readily assembled and require no great amount of adjustment. To get up an annunciator under these limitations that will not stick or bind, or fail to reset, and that will remain in working order for years without attention, is a problem requiring the exercise of considerable ingenuity.

Fig. 12 shows an annunciator recently brought out by the Star Electric Company, Binghamton, N. Y., designed to meet these conditions. As may be seen from the figure, the armature, A, consists simply of a rectangular piece of sheet iron with two holes, which are slipped over the prongs, P, shoulders on which serve as pivots. This armature is held away from the magnet cores by the hook-shaped spring, S, of sheet brass, and holds the indicator shaft by engaging the heel, H, of the lever, L. When the armature is drawn down by the magnets this lever falls, due to the weight, W, after which it is reset as usual by the arm, B, on the restoring shaft.

The advantages of this construction are several. The armature being suspended at its center of gravity, is not likely to be thrown by any mechanical shock or jar. The spring being of the flat type, and having a very slight motion, does not require readjustment, and will not break or weaken even after long and severe use. In the event of any armature sticking to the magnet when the drop is operated, the projecting toe, T, strikes the right-hand side of the armature when the drop is reset and restores the armature to its proper position. When any drop is reset, the in-

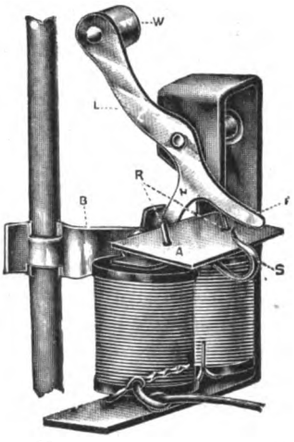



FIG. 12.—AN ANNUNCIATOR DROP.

dicator shafts of all the other drops are slightly disturbed, thereby keeping them free in their bearings. All iron parts are copper-plated to prevent corrosion.

The bell is mounted on the front cover, so that, by removing the screws fastening this to the sides of the case, the bell may be readily removed for adjustment or repairs.

This type of annunciator is termed by the makers "Style E."

### A DIRECT READING POWER GAGE.

The measurement of the power given by the steam to the piston of a steam engine has always been an elaborate operation and rarely a satisfactory one, involving as it does the manipulation of delicate apparatus under trying circumstances, subsequent careful measurements with a planimeter and calculations from the figures obtained. While apparatus for this purpose has been brought to a high stage of perfection the difficulty and trouble experienced by the ordinary engineer in taking cards, measuring them and calculating the results, together with the fact that on varying loads these cards do not give average results, render the indicator an instrument for fine analytical work, rather than the every-day measurement of power developed. The power gage described below is intended to give at all times an indication of the power being developed in the cylinder as easily read as the steam gage or the switchboard instruments.

The principle upon which this instrument operates is the driving of a miniature turbine by jets of steam from the cylinder ends and measuring by means of a simple form of tachometer the speed of this turbine. Two pipes run to the instrument respectively from the two ends of the cylinder of the engine, the power of which is to be measured. Each pipe terminates at its upper end in two small nozzles which direct jets of steam upon the buckets of a small steam turbine imme-

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diately over them. This turbine drives a retarding device consisting of an air fan running in an enclosed chamber, in which there is also a non-rotating fan. This latter fan is mounted on a shaft with a retractile spring, and carrying also an indicating needle. As the turbine rotates, the movement of the air set up by the fan which it drives drags around the indicating fan. This drag is balanced by the retractile spring and measured on the indicating dial. The torque is dependent upon the velocity of the turbine, which in turn is dependent upon the time average of the pressure of the steam jets, so that the indication is a measurement of this pressure. The turbine has sufficient mass to give a fly-wheel effect which maintains an approximately constant speed under the intermittent impulses of the jets.

Each entering pipe from the steam cylinder has two nozzles se. to drive the turbine in opposite directions. One of these nozzles is opened during the forward stroke and the other during the return stroke of the piston by means of a small shutter thrown over by a tappet motion operated from the crosshead just at the instant when the crank reaches the dead center. The shutters are so arranged that the back pressure and compression during the return stroke of the piston operate on the jet tending to retard the motion of the turbine set up by the forward pressure in the other end of the cylinder. Thus the turbine gets a resultant forward pressure proportional to the average pressure on both sides of the piston.

The uses of an instrument of this kind are numerous, among them the following: An indication of bad valve adjustment; an indication of the friction load every time the engine is started; from which the general condition of the plant may be ascertained; an indication of the division of the load between the cylinders of compound or triple-expansion engines; an indication of the relative amount of work done in each end of the cylinder; this can be obtained by simply turning the cocks at the two ends alternately; an indication of the stability of governing, if a governor "hunts" or "see-saws" the power developed in the cylinder will fluctuate rapidly; and a means of determining whether any unusual losses shown between the coal pile and the switchboard are on the steam or the electrical side of the engine cylinder.

This instrument is the invention of Mr. G. F. Atwood, and is being placed upon the market by the Atwood Power & Speed Gage Company, New York City.

THE MIETZ & WEISS KEROSENE ENGINE.

For the driving of electrical generators requiring close regulation an internal combustion engine which delivers one impulse per revolution is naturally better suited than is the ordinary type of gas engine which gives one impulse during two complete revolutions. An engine of the two-stroke cycle type, as it is called, made by August Mietz of New York City, is shown in Fig. 13, coupled to a Lundell generator. The means of obtaining one explosion per revolution are as follows:

The crank case is enclosed and every time the piston makes an outward stroke the air within the crank case is compressed to about three pounds per square inch. At the end of the outward stroke the piston uncovers an exhaust port in the lower side of the cylinder and also an admission port in the upper side of the cylinder, through which the air compressed in the crank chamber rushes and drives the burned gases out through the exhaust port. On the return stroke of the piston the ports are first closed, the fresh air in the cylinder is compressed, a suitable amount of oil is pumped in and the mixture is ignited at the end of the stroke. The explosion and expansion follow until the piston reaches the outer end of the stroke, uncovering the ports and allowing the burned gases to exhaust, after which the cycle repeats itself once per revolution.

The engine may be said to have no valves, or, rather, the piston becomes its own admission and exhaust valve.

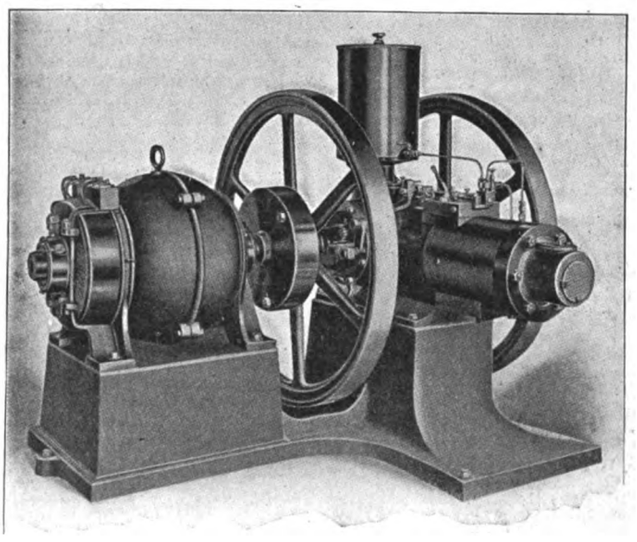


FIG. 13.—A TWO-STROKE CYCLE OIL ENGINE DIRECT COUPLED TO A GENERATOR.

The governing is effected on the "hit or miss" principle by simply missing strokes of the oil pump and thereby failing to deliver oil to the cylinder during one revolution. The air compression and expansion go on during idle strokes just as they do during working strokes. The governor itself is most simple in character, as it contains no springs nor weights whatever. It simply consists of an oscillating weight driven by an eccentric back and forth over an inclined surface on which it rests, but from which it is free to rise. Normally when this piece is driven forward by the eccentric it engages the stem of the oil pump and pumps a charge of oil to the cylinder. The inclined plane stops a little short of the position at which the oscillating piece or pusher engages the pump stem so that this piece rides over on to a level surface. If the speed rises above normal the pusher does not ride over on to the horizontal surface, but continues, due to its own inertia, up into the air in the direction of the inclined plane, thus missing the pump stem and failing to deliver oil to the cylinder. As soon as the speed falls to normal the oscillating piece again follows the path to which it is held by gravity and again engages the pump stem and delivers fuel to the engine.

The engine is started with a hot igniter, but the external heat for this may be turned off after the engine is once started, the compression being sufficient with the temperature at which the igniter remains to ignite the gases at the proper instant. The engine is fitted with a very simple lubricating system, the oil being drawn into the points to be lubricated from a tank on the side of the engine and through sight-feed oil cups simply by means of the intermittent suction set up in the crank case. The oil is supplied in this way to two points; one the piston and the other the connecting rod from which it passes to the crank pin. The main bearings are lubricated by ordinary ring oilers.

The flexible coupling shown in the illustration consists of three studs on the engine fly wheel and three on the generator disc. These studs are connected together in pairs by rubber links or bands, which stretch considerably and take up any slight irregularity in the motion of the engine.

## NEW BOOKS.

The Columbia Engineer. New York: The Engineering Society of Columbia University; 144 pages, illustrated. Price, $1.00.

The annual publication of the Engineering Society of Columbia University, containing the lectures delivered before this society, with complete illustrations, is a student annual intended chiefly for the members of the society. Owing to the increasing call for the volume from others of the engineering profession it has been considered advisable to place the book on sale at the price given above.

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A Dividend to Labor. By N. P. Gilman. Boston: Houghton, Mifflin & Company. 400 pages. Price, $1.50.

While it is not the custom to review in these columns works which are not of an engineering or electrical character, this book is of such great interest to employers of labor that it deserves notice here. Mr. Gilman is a well-known authority on this subject, being the author of a previous work entitled "Profit Sharing Between Employer and Employee." His latest work is intended to be a study of profit-sharing and similar institutions in which part of the profits are appropriated for the benefit of the employees. Five cases of profit sharing are described in detail. Among them are the Bourne cotton mills of Fall River, Mass., the establishment of the Procter & Gamble Company, Cincinnati, Ohio, and the Nelson Manufacturing Company, Leclaire, Ill.

## LEGAL NOTES.

BENJAMIN A. GOULD VS. THE EDISON ELECTRIC ILLUMINATING COMPANY OF NEW YORK.—An interesting case concerning the rights of the central station to make a minimum charge was the subject of an opinion handed down by Judge Beekman of the New York Supreme Court, October 24, 1899. The suit was brought to compel the Edison Company to re-connect the premises of the plaintiff. Damages to the extent of $500 were also demanded for the refusal of the company to comply with the plaintiff's demand after the plaintiff had refused to meet the minimum payment of $1.50 per month when the charges for current consumed fell below that sum. The opinion held that the charge was a reasonable and justifiable one, since it was claimed by the defense that each new lamp connected to the system required an additional outlay in the generating and distributing plant of $20. Since the number of lamps connected for the plaintiff was 11, the additional investment necessary to supply these lamps at any time they might be wanted amounted to $220. Judgment was accordingly ordered in favor of the defendant.

## PERSONALS.

MR. CHARLES T. CHILD, technical editor of the "Electrical Review," was married on November 30th to Miss Bertha May Cushing of Malden, Mass.

MR. H. J. RIFFEL, who, until recently, was connected with the Siemens & Halske Company, has severed his connection with that concern to join the staff of the Belknap Motor Company of Portland, Maine.

MR. C. S. KNIGHT has resigned from his position as Vice-President and General Manager of the Siemens & Halske Electric Company of America and will be succeeded by Mr. O. S. Lyford, Jr., formerly chief engineer of the Westinghouse Electric & Manufacturing Company, and since electrical engineer of the Siemens & Halske Company. Mr. Knight will take up other work for the Whitney Syndicate in the East.

Mr. W. W. BURNHAM, for fifteen years or more connected with The Electric Gas Lighting Company of Boston, and for four years manager of that company, has recently associated himself with the firm of Messrs. Stanley & Patterson, New York, dealers in electrical supplies. Mr. Burnham will have general charge of their correspondence. His experience and acquaintance with the electrical trade should prove of service to him in anticipating the wants of his old friends and customers.

MR. RUSSELL THOMAS KINGSFORD, who was for several years chief engineer of the American Impulse Wheel Company, has resigned that position and is now chief engineer of the Rushmore Dynamo Works of Jersey City. Mr. Kingsford is a graduate of Stevens Institute of Technology and has had extensive experience in designing dynamo machinery. He will assume entire charge of the building of the new line of large multi-circuit arc machines, relieving Mr. Rushmore, who will now give his attention largely to developing his rapidly increasing searchlight and optical business.

## TRADE PUBLICATIONS.

THE FALCON ELECTRIC MANUFACTURING COMPANY, New York City, has published bulletin No. 1 on "Falcon All-Drawn Pure Copper Knife Switches."

THE ELECTRIC APPLIANCE COMPANY, Chicago, has issued a pamphlet giving a description and prices of the Gutmann recording wattmeter, for which the company acts as Western selling agent.

THE REEVES MACHINE COMPANY, Trenton, N. J., has published a small pamphlet on the subject of "Harthan's Metallic Rod Packing" which the company is now making for service on piston rods, valve rods, etc.

THE WESTERN ELECTRIC COMPANY'S latest bulletin is on the subject of "New Type Sunbeam Incandescent Lamps" and calls particular attention to the lamp of this make designed for railway work. These lamps are also described in a new catalogue, No. 1-S.

THE MANHATTAN ELECTRICAL SUPPLY COMPANY, New York City, has published a new general illustrated catalogue No. 7 on electric light, household, telephone and telegraph electrical supplies. The catalogue is a very comprehensive one, running up to 352 pages.

THE PAYNE COMPANY, Elmira, N. Y., has brought out a new catalogue on the Payne high-speed automatic engine. The catalogue is illustrated throughout by views of engines direct coupled to electrical generating sets. The catalogue gives detailed drawings of several special points in the Payne engines, such as the valve and the crosshead.

THE STERLING VARNISH COMPANY, Pittsburgh, Pa., has published a booklet of testimonials, each page consisting of a reproduction of a letter of recommendation of Sterling varnish from some maker or user of electrical machinery. There are some 70 of these pages, many of them coming from the largest and best known concerns. The book is also being printed in French and German editions for distribution abroad.

THE MURRAY IRON WORKS COMPANY, Burlington, Iowa, is circulating a new catalogue of the Sioux Corliss engines. The catalogue illustrates and explains with clearness the various forms of this make of engine and the meritorious details, such as the improved form of girder frame, the high-speed ball-bearing governor, the insulation of the exhaust passages from the cylinder, the improved valve motion and dash pots and several other valuable points.

THE SPRAGUE ELECTRIC COMPANY, New York City, has brought out catalogue No. 75, entitled "Interior Conduit," covering the various styles of conduits made by this company, viz., iron-armored, brass-armored, unarmored, and flexible metallic, with insulated fitting boxes, elbows, couplings, etc. The catalogue is a most complete one of 148 pages and gives a great deal of valuable information on the subject of interior wiring in conduits. All wiring contractors will find it valuable for this information if for no other reason.

MR. JAMES G. BIDDLE, Philadelphia, has created quite a stir among college professors and electrical engineers by issuing circular No. 315, entitled "New Apparatus at Special Prices." It describes a considerable number of high-grade electrical measuring instruments as well as psychological apparatus, which, for reasons explained in the pamphlet, are offered for sale at remarkably low prices. These figures would be impossible under other circumstances, and are especially noticeable now when the tendency of prices is upward.

THE INTERNATIONAL CORRESPONDENCE SCHOOLS, Scranton, Pa., have started another regular publication entitled "The Official Messenger." This periodical is issued for free distribution among employees, and is intended to serve as a medium of communication between the home office and the force of men in the field. The initial number is devoted to a detailed description of the work and equipment of the schools, with photographs of heads of departments, instructors, etc., and views of the buildings, offices, press rooms, etc.

THE BOSSERT ELECTRIC CONSTRUCTION COMPANY, Utica, N. Y., has brought out two new descriptive catalogues, one on panel boards and the other on the Bossert plugged-steel outlet boxes and Erickson conduit insulators. The Bossert Company has standardized a line of panel boards sufficiently comprehensive to supply all ordinary demands. The company also makes, in addition to its steel outlet boxes and steel boxes for panel boards, a line of cast-iron boxes for all styles of General Electric cutouts and is even extending its output of general fixture boxes so far as to include boxes for mine or underground work.

THE ELECTRIC STORAGE BATTERY COMPANY has published circular No. 55 under date of Oct. 1, 1899, entitled "The Application of Storage Batteries in Railway and Power Plants," being a reprint of the paper by Mr. Herbert Lloyd in the electric railway number of "Cassier's Magazine." This bulletin gives useful data, one special piece being a curve of voltages of a cell under rapidly recurring charges and discharges. The bulletin also describes several well-known storage battery sub-stations, such as those of the Buffalo Railway, the Metropolitan Railway of New York City and the South Side Elevated Railway of Chicago.

THE WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY has brought out during the past month two notable additions to its line of handsomely illustrated descriptive pamphlets, one on "Westinghouse Railway Motors" and the other on "The Westinghouse Electro-Pneumatic System for Controlling Railway Motors." The electro-pneumatic system is virtually what is commonly called a "multiple-unit system," whereby scattered motors throughout a train of motor cars may be all controlled simultaneously from any desired platform. The controlling apparatus is pneumatic in character, being worked by the compressed air of the air-brake system. The controlling and braking system are interlocked so that the brakes cannot be applied while the power is on nor the power applied while the brakes are on.

THE WESTERN ELECTRIC COMPANY publishes a convenience for central stations in the shape of what is called "The Meter Record Book." This consists of a book of

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blanks, each a fac simile of the dials of an integrating wattmeter. There are 250 of these blanks in a book, perforated so that they may be readily torn out and numbered successively. Four books constitute a set and the blanks of these four are numbered consecutively from 1 to 1000. The book is used by the meter man on his rounds. With a lead pencil he marks the fac simile of the dial so as to show the exact position of the hands on the meter face. The form is returned to the office, proper extensions are made, and the slip is filed for reference. The record book is capable of other useful applications. The man who reads the meter may tear out a slip and leave it with the consumer to give a record by which the latter may compare his bill.

THE SKINNER ENGINE COMPANY, Erie, Pa., has published a catalogue covering its new system of automatic lubrication. The system consists of a pump delivering the oil from the supply tank to an overhead reservoir from which it flows by gravity to the points to be lubricated. The pump is driven by the valve rocker. The oil is fed to the crosshead guides and shaft boxes by means of hinged feeder pipes which can be turned back to provide ready access to the parts below them. These feeders contain regulating screws by means of which any desired number of drops can be maintained through sight-feed glasses placed below them. When these feeders are thrown back the supply is cut off. The oil passes from the bearings to an oil and water separator, from which the separated oil returns to the reservoir, which, in turn, contains a purifier containing no filtering material nor anything that requires renewal, but effecting, it is claimed, a perfect purification.

"THE VICTOR TELEPHONE JOURNAL" is the name of a new publication devoted to independent telephone interests, and particularly to the advancement of the business of the publisher, the Victor Telephone Manufacturing Company of Chicago. The editor of the new publication is Mr. Wm. T. Blaine, President and General Manager of the Victor Company. Vol. I., No. 1, which is dated October, 1899, states that "The Victor Telephone Journal" will appear "every little while, as improvements, the accumulation of interesting information, and other conditions make it desirable. This will probably be once a month." The paper takes no advertising and has no subscription rates—i.e., it is sent free to those who feel sufficiently interested to send their names. The first number warrants much more than this effort on the part of subscribers, as it contains, in addition to information about Victor telephone apparatus, some valuable instructions concerning the equipment of party lines for toll service wired on the bridging system, and with switching stations between divisions.

THE SIMPLEX ELECTRICAL COMPANY, Cambridgeport, Mass., has brought out two descriptive catalogues, one on rheostats made up on the "unit" system, and the other on electric car heating on the "American" system. The "unit" system rheostats are now made up in the form of motor controllers with automatic release, as well as a form of theatre dimmers. An entirely new type of car heater has been developed, known as the "enamel" car heaters. They consist of cast-iron plates on one side of which the resistance wires are embedded as in enamel rheostats. The cast-iron surface is not covered by any casing or netting, but is opened direct to the air of the car. On account of the large surface for radiation which can be obtained in this way as compared with that of coiled spring types, a lower temperature heater can be utilized, giving a larger amount of air heated moderately than is possible with other types. This heater is advocated particularly for elevated railroad cars. A hose may be used for cleaning the car without fear of injury to the heaters.

## BUSINESS NEWS.

MORSE, WILLIAMS & CO., Philadelphia, Pa., the elevator manufacturers, have removed their offices to the twelfth floor of the West End Trust Building. Their factory address, however, will remain the same.

THE ELECTRIC APPLIANCE COMPANY, Chicago, is sending out samples of its new "Eaco" tape. It is claimed that this tape is composed of one-third pure rubber and has the qualities the trade is looking for.

THE H. C. ROBERTS ELECTRIC SUPPLY COMPANY, Philadelphia, has purchased the fixtures, stock and good will of the Franklin Electrical Supply House of the same city and will fill all unfilled orders previously received by the latter house.

THE UNITED STATES CARBON COMPANY suffered to the extent of $10,000 by fire at its works in Cleveland, Ohio, on the evening of Nov. 19th. The plant was immediately put in order again, and by the time this paper reaches its readers will be working as before.

THE BURT MANUFACTURING COMPANY, Akron, Ohio, has recently received an order for a Cross oil filter from the remote point of Seoul, Corea. The order is from the Seoul Electric Company, the filter being purchased on the recommendation of the chief engineer.

THE SAFETY INSULATED WIRE & CABLE COMPANY of New York City is about to construct a $500,000 manufacturing plant on tide water in the vicinity of Bayonne, N. J. A tract of 15 acres has been secured and it is expected that sufficient buildings will be erected inside of six months to house 400 hands.

MESSRS. GILLESPIE & TARTT, Edwardsville, Ill., have placed on the market "Gillespie's Balance for Incandescent Lamps," the new form consisting of two simple wheels or pulleys around which the lamp cord is run, the upper wheel hanging from the lamp support and the lower one carrying the counterweight.

THE YORKVILLE ELECTRIC CONSTRUCTING COMPANY, New York City, has been formed by Mr. Wm. Jacobs to carry on work in his particular lines of electric bells, electric signs, burglar alarms, gas lighting, telephone work, etc. The headquarters of this company will have facilities for handling the work in these lines.

THE MONTAUK MULTIPHASE CABLE COMPANY, New York City, received most favorable mention in the report of the Committee of Exhibits of the Convention of the National Association of Municipal Electricians recently held in Wilmington, Delaware. The report held that the cable and its appurtenances are a great boon for the protection of life and property.

THE NATIONAL CONDUIT & CABLE COMPANY, New York City, has recently received two large orders for underground cables. One of these covers 150,000 feet of 1,500,000 circular mils lead-covered cable to be used as feeders for the electrical conduit railroad system of the Third Avenue Railroad Company of New York City. The other is a large order from Glasgow, Scotland.

G. E. LINTON & COMPANY, Worcester, Mass., is the name of a new company formed by Mr. G. E. Linton, formerly of the Linton Manufacturing Company, to do a general electrical business. The new company will pay particular attention to the construction of electrical switches and switchboards. Mr. Linton's experience and practical knowledge of this line of work should go far toward assuring the success of the new company.

THE WESTERN ELECTRIC COMPANY is installing three 70-h. p. motors in Schlesinger & Mayer's building, Chicago. These motors are especially designed to drive the pumps for the elevators, and are to work against a constant pressure of water at all speeds. The speed variation, which is from 175 to 350 revolutions per minute, is governed by an automatic controller which cuts in or out various sections of the series field winding.

THE GARTON-DANIELS COMPANY has been incorporated to continue the business of the Garton-Daniels Electric Company, with headquarters at Keokuk, Iowa. It is the intention of the new company to add other specialties to its line of manufact-


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ures, announcement of which will be made later. With increased capital and better facilities, the new company will be better equipped than was the old to handle the increasing demand for Garton lightning arresters.

THE AMERICAN DISTRICT STEAM COMPANY has recently occupied newly erected shops in Lockport, N. Y. These shops are 66 x 100 ft. in plan and four stories high, giving room to accommodate the increasing business. The company has recently shipped the material for a complete district steam heating system to the Seattle Heat, Light & Power Company at Seattle, Wash. The system will comprise over a mile of distributing mains ranging in size from 18 in. down

THE SPECIALTY MANUFACTURING COMPANY, Indianapolis, Ind., manufacterer of exhaust, blow and ventilating fans, has removed to new quarters a block from the old location. In the new quarters the company has largely increased facilities and all of the modern factory equipment for turning out a greater product. A large installation of exhaust fans for the Hotel English in Indianapolis was recently completed by this company and is giving satisfactory service.

THE AMERICAN STEEL & WIRE COMPANY, Chicago, reports regarding the partial destruction by fire of its plant at Waukegan, Illinois, Saturday afternoon, November 4th, that arrangements have already been made for the execution of unfilled orders at Waukegan by its other plants, and assures its customers that all orders now placed which have been lodged at Waukegan for shipment, will be taken care of by shipment from other plants with very little, if any, delay.

THE NEW ENGLAND MOTOR COMPANY, Lowell, Mass., is placing on the market a line of iron-clad motors in small sizes ranging from ¼ h. p. to 5 h. p. These machines can be used either completely or semi-enclosed; are fitted with Bayliss reaction-type brush holders and are claimed to be first class in every respect. They are particularly adapted for direct connection to fans, beer pumps, etc., and form a desirable addition to the line of machines already placed upon the market by the same makers.

THE C & C ELECTRIC COMPANY, New York City, reports that it has been recently running behind on deliveries owing to the impossibility of obtaining steel castings, but it is now daily receiving large consignments, which will soon allow it to put on a night force and catch up with orders. The company expects to have ready for the market in a short time the new line of dynamos and motors ranging from two to 40 kw., to be known as the type F. P. The special features of these machines will be announced later.

NO CONSOLIDATION OF THE SPRAGUE AND STANLEY COMPANIES.—At a meeting of the directors of the Sprague Electric Company the consolidation of the company with the Stanley Electric Manufacturing Company of Pittsfield, Mass., was not confirmed, and the companies will be operated independently, although to some extent owned by the same individuals. Mr. Henry Hine will retain his position as General Manager of the Stanley Company. Mr. Allan C. Bakewell was appointed General Manager of the Sprague Company.

THE UNION BOILER TUBE CLEANER COMPANY, Pittsburgh, Pa., has just completed a contract for cleaning two Hazleton, or Porcupine boilers, having over two thousand tubes, each, as is well known, having one closed end. These tubes were badly scaled and the closed end required a special tool of unique design, as well as the use of the company's own design of flexible shaft. This company claims to be the only one on the face of the globe being fully equipped with machinery, tools and expert operators to do this kind of work quickly, effectively and cheaply.

THE PLAYFORD STOKER COMPANY, Cleveland, Ohio, cites a striking example of what can be done toward smoke prevention by the use of proper grates and mechanical stokers in the case of the installation in the Telephone Building in Cleveland. Two boilers with a complete Playford equipment are in use and the most careful observer cannot detect the faintest escape of black smoke from the stack. The combustion of the coal is nearly perfect. This company is also just completing a large installation of forty-five of its stokers for the extensive iron and steel works of the Apollo Iron & Steel Company of Pittsburgh.

MR. P. C. ACKERMAN, who for the last thirteen years has been identified with the American Electrical Works as its representative in New York City, has been appointed general sales agent for the Rhode Island Electrical Works, of Pawtucket, whose officers are Eastwood Eastwood, President; C. G. Wood, Treasurer, and A. F. Montgomery, general manager. The company is now making magnet wires in sizes from No. 14 to No. 40, and Mr. Ackerman is already securing some very nice business. He has opened headquarters at the Havemeyer Building, 26 Cortlandt Street, where he will be glad to receive orders and inquiries and all his old friends.

GEORGE W. LORD, Philadelphia, manufacturing chemist, and proprietor of Lord's boiler compounds, has found it necessary to move into new quarters from the old location which has been occupied so long, twenty-three years, that all possible additions have been made to the building on that site. The new plant is located at 2238 to 2250 N. 9th Street, Philadelphia, where it covers a ground space of 150x175 feet. The building is three stories high, with a base-


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ment, and with foundations and walls sufficiently strong to allow the addition of three more stories in the future. The move was to be made on or about December 1st.

ELMER P. MORRIS gave a dinner at the Bingham House in Philadelphia on the evening of the 14th, in commemoration of the first shipment of material for the new street railway system in Havana, which is being built by the Morris Electric Company of New York. Eighteen gentlemen interested in electrical and transportation enterprises were present. The shipment consisted of 50 carloads, in two trains, of Mason terra cotta conduits from the works of the Potomac Terra Cotta Company, near Washington, which were transported by rail to Philadelphia, and there loaded aboard ship for transportation by water to Havana. The shipment will be followed later by others of trolley poles, tools, machinery, equipment, etc., aggregating in all about 182 carloads. The line will comprise about 27 miles of track.

THE BULLOCK ELECTRIC MANUFACTURING COMPANY, Cincinnati, Ohio, reports 55 orders for the month of October, the machines ranging in size from the smallest to 300 kw. capacity. A repeat order was received from the Maryland Steel Company of Sparrows Point, Md., this making the fifth order, and being for a 300-kw. generator and several motors. Orders were received from the London, England, "Star" and St. Petersburg, Russia, "Novia Vremia," two of the most important papers of the respective cities, for the Bullock "teaser" equipment for operating newspaper presses. Two 300-kw. alternating-current generators were shipped to the Wilson Aluminum Company of Holcombs Rock, W. Va., to be used in the manufacture of ferro-chrome, an electrical product used in the manufacture of chrome steel.

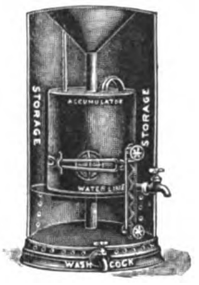
THE HAZARD MANUFACTURING COMPANY has recently extended its works in Wilkesbarre, Pa., previously devoted to the manufacture of steel, iron and galvanized iron rope, to include the manufacture of insulated electrical conductors. The new department is equipped with modern and improved facilities for the production of insulated wires and cables of various types demanded by the market, such as weatherproof, fibre and rubber insulation in standard sizes of wires, and braided, taped or lead-covered cables. The rubber compound is styled by the term "Keystone." The company also makes a "Hazard white core" or "Hazard solid core" insulation. The company also makes bare copper wire, magnet wire, annunciator wire, flexible lamp cords, iron line wire with weather-proof insulation, and galvanized telegraph and telephone wire and galvanized steel wire strand for guy and span wires.

THE AMERICAN ENGINE COMPANY, Bound Brook, N. J., reports that it has just secured the order for the entire electrical equipment of the Standard Paint Company of Bound Brook, consisting of an American-Ball duplex compound engine and direct-connected generator of 75-kw. capacity, and a full equipment of motors of various sizes for the electrical transmission. Among recent orders for these new duplex compound engines the American Engine Company reports the following: 200 h. p. for Western Electric Company, Chicago; 200 h. p. for Continental Iron Works, Brooklyn; 200 h. p. and 80 h. p., with direct-connected generators, for McCreery & Co., New York; 120 h. p., with direct-connected generator, for Marlin Fire Arms Company, New Haven; two 80 h. p., with direct-connected generators for F. H. Richardson, Newark, and one 80 h. p. for Weston Electrical Instrument Company, Newark.

MR. JAMES G. BIDDLE, Philadelphia, as selling agent for Messrs. Morris E. Leeds & Co., is supplying conductivity testing outfits for the Boston & Montana Consolidated Copper & Silver Mining Company, and also for Professor Robb of Trinity College. These equipments are similar to those which Mr. Biddle has supplied to John A. Roebling's Sons Co., Bridgeport Copper Co., Seymour Mfg. Co., Coe Brass Mfg. Co., Waclark Wire Co., Bridgeport Brass Co., Michigan College of Mines, Guggenheim Smelting Co., Pittsburg Reduction Co., Lake Superior Smelting Co. and Stanley Electric Mfg. Co. It is a matter of vital importance to be able to accurately measure the electrical conductivity of copper wire and rod in small lengths. The same also applies to other metals to a certain extent, especially aluminum, which is now being introduced for transmission purposes. It is believed that the special outfit furnished the Pittsburgh Reduction Co. is the first one that has been used for tests of this character with aluminum.


**NON-TERRITORIAL EXPANSION**

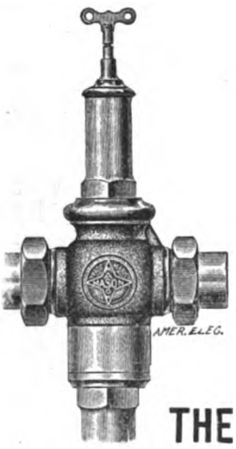
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# AMERICAN ELECTRICIAN

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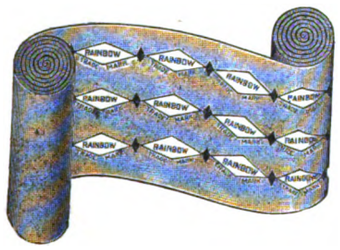
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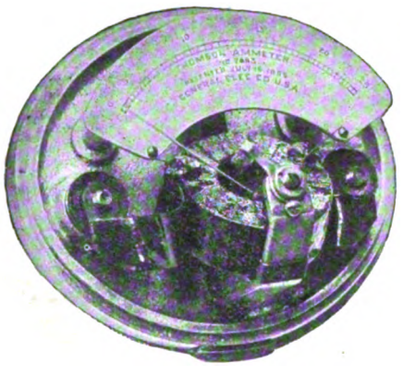
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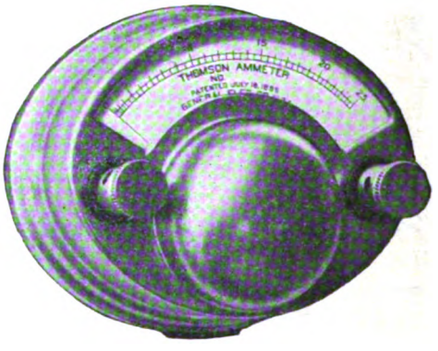
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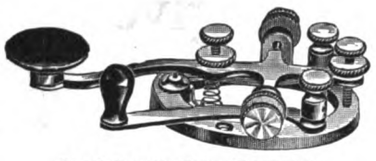
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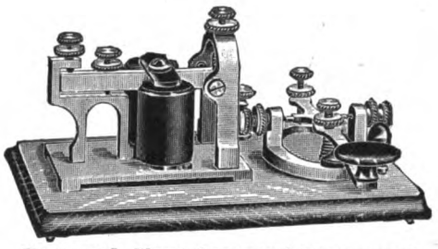
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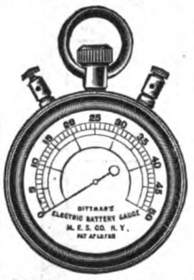
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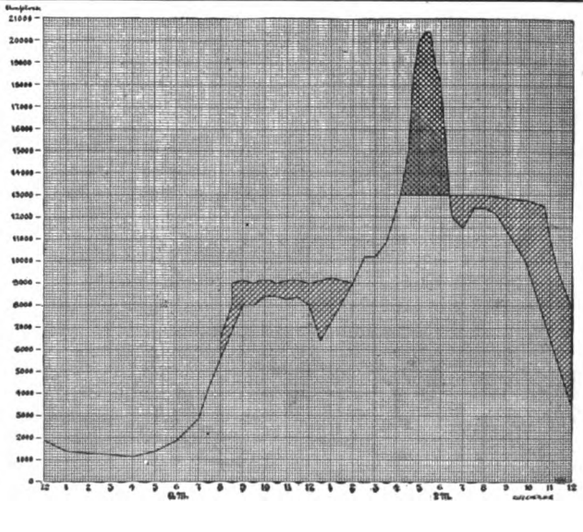
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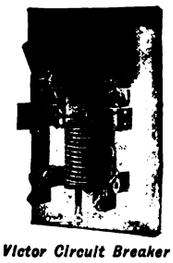
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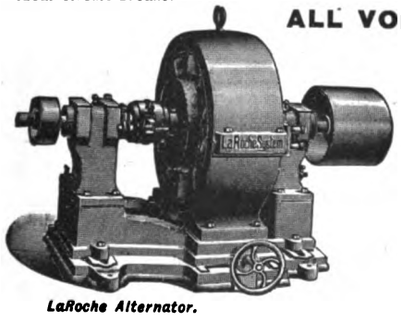


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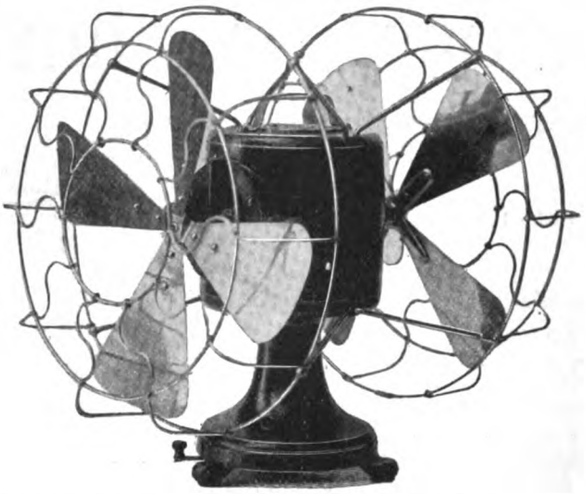
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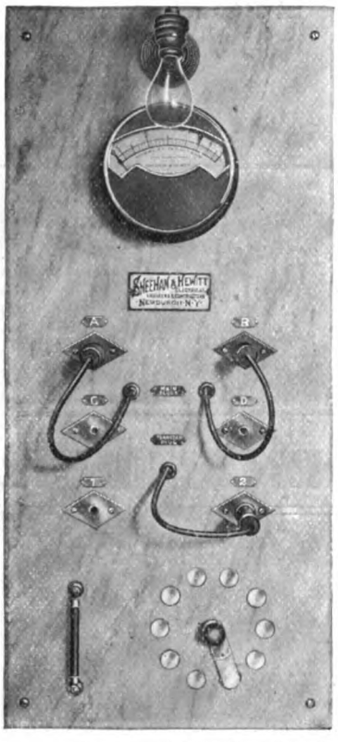
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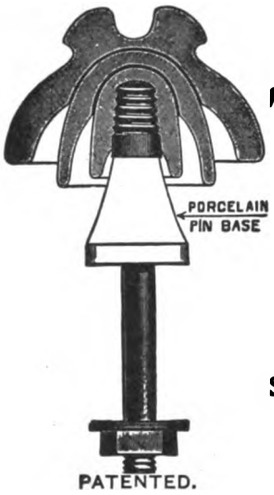
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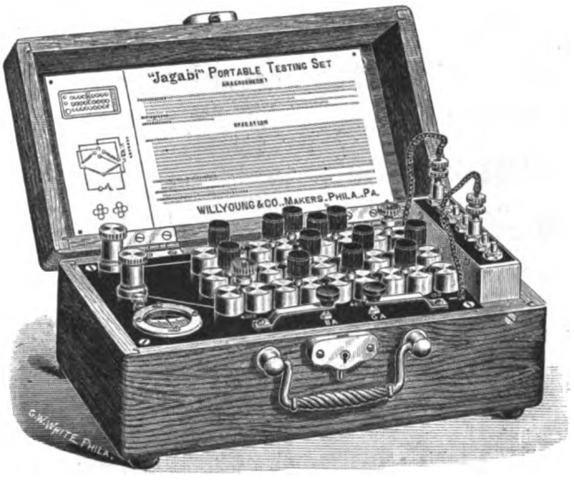

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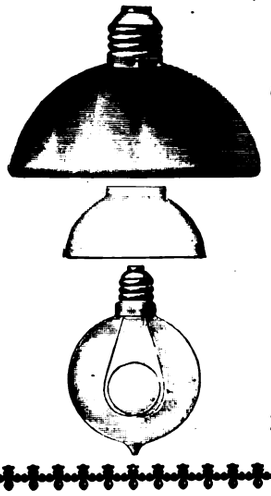
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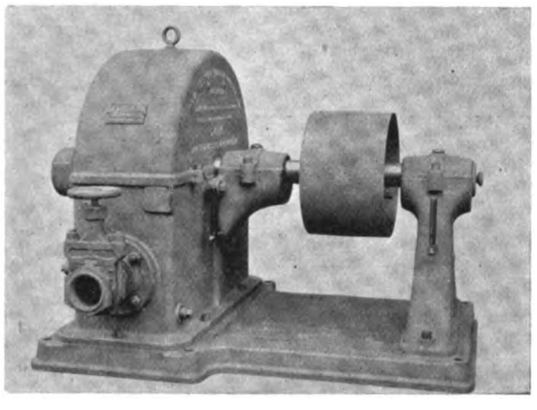
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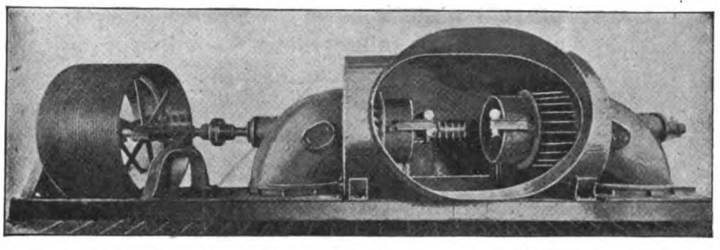
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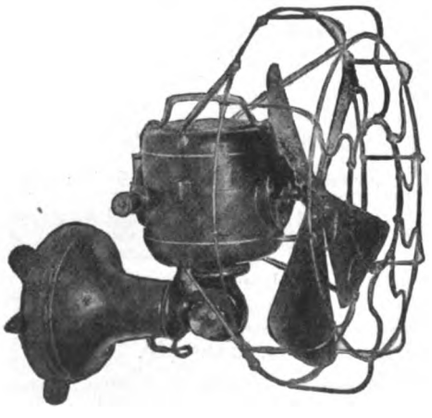
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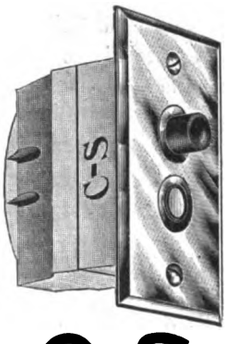
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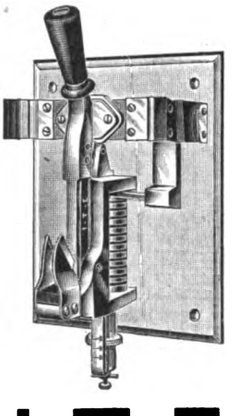

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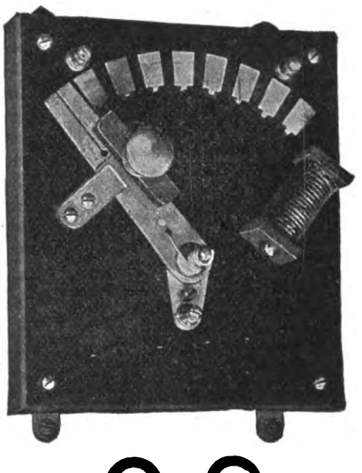
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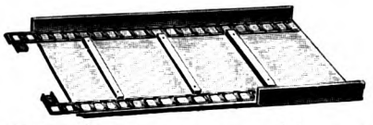
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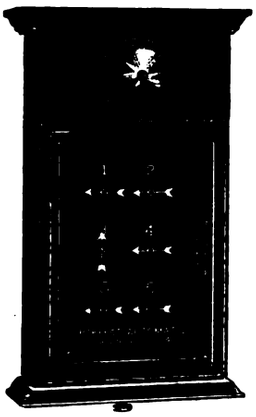
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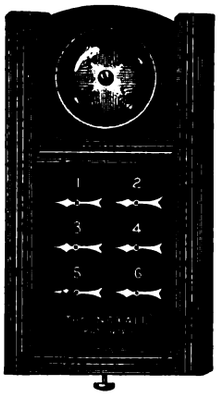
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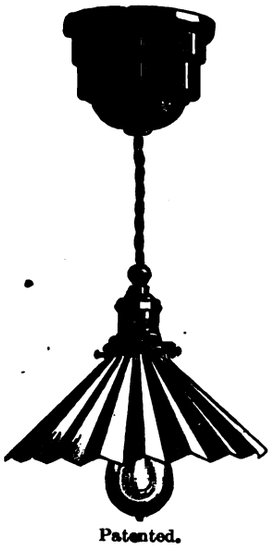
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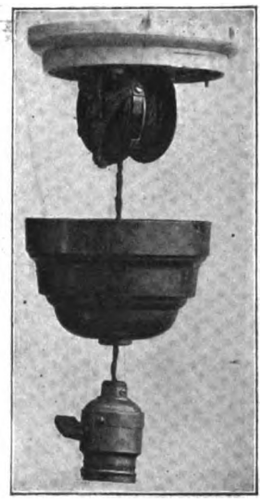
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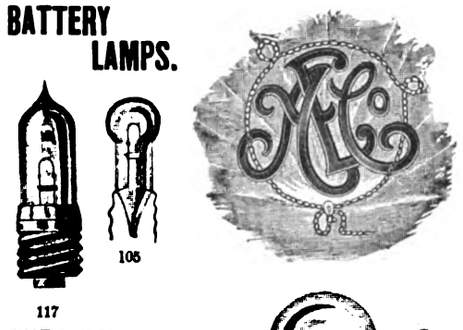
**Some of our special X-Ray Tubes** have Iridium Targets. The regulars have Platinum Targets. We are still making the best Barium Fluoroscopes.

**Edison Decorative and Miniature Lamp Dept.**

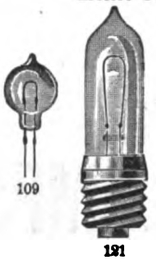
(General Electric Co.)

**HARRISON, N. J.**

**BATTERY LAMPS.**

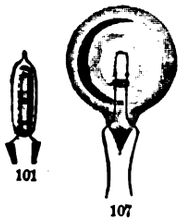



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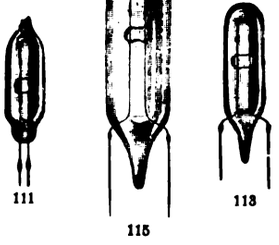






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*The Most Powerful Competitor of the Incandescent Gas Lamp.*

2½ AMP.
110 VOLTS.
STEADY LIGHT.
SMALL COST.
50 HOURS.

**A BOON to Central Stations**

*Write for Prices.*

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AGENTS:
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IS ASSURED ALL USERS OF

## McINTYRE'S DRY BATTERY

## Portable Electric Safety Lamp.



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No. 4. Weight, 3 lbs., 4 C. P. For Boiler Makers and Chimney Sweeps. Price, complete..... ..... 6.00

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FOR DIRECT CURRENT ARC-LAMPS

FOR ALTERNATING CURRENT ARC-LAMPS

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HIGHEST GRADE NUERNBERG CARBONS

UNEQUALLED IN QUALITY AND EFFICIENCY

ABSOLUTELY STEADY AND BRILLIANT LIGHT.

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**Notice.** See that every package of my Carbons bears the label with my trade-mark, "Electra," thus, Beware of imitations. To protect the interests of purchashers of my Carbons I am determined to proceed against infringers of my "Electra" trade-mark.

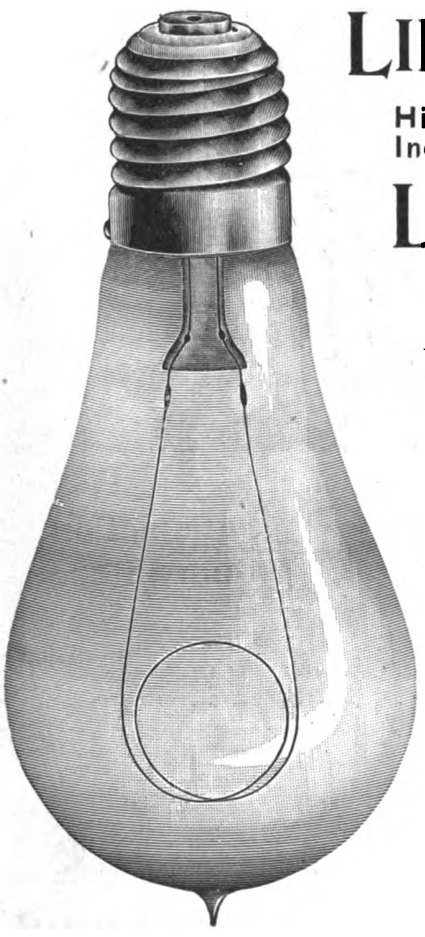
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HAVE STOOD THE TEST OF TIME

COMMUTATOR BARS

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LIBERTY

High Grade Incandescent

LAMPS.

Owing to the rapidly increasing demand for LIBERTY LAMPS we have removed our factory to Malden, Mass., where we have a capacity of 5,000 lamps daily . . . .

We Solicit a Trial Order.

Liberty Lamp Co.

17 to27 James St.,

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A NEW INVENTION!!

Keep your Lights Clean and Renew Same when burnt out by using

The Incandescent Electric Light Manipulator

Thereby doing away with Staging, Extension or Step Ladders.

It is made to fit ANY candle-power bulb, of ANY standard make, at ANY HEIGHT or ANGLE.

Telescopic Pole.

JUST WHAT IS NEEDED for Halls, Cars, Steamboats, Depots, Hotels, Theatres, Street Lights, Residences, Public Buildings, Stores, etc., etc.

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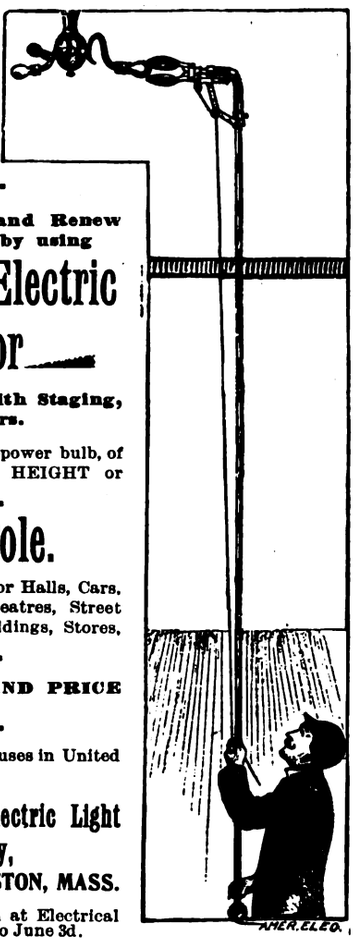
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Manufactured by . . .

The Incandescent Electric Light Manipulator Company,

ROOM 506, 116 BEDFORD ST., BOSTON, MASS.

Can be seen in practical operation at Electrical Exhibit, New York, May 8th to June 3d.




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WHAT WAS DONE.

An oppressed race was relieved of its burden.

# DEWEY AND THE ORIENT



Quality Unexcelled.

**Incandescent Lamps**
FOR EVERY USE.

Satisfaction Guaranteed.

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## AND ENJOY THE MUSIC




"IT NEVER DISAPPOINTS"

## THE OKONITE CO., LTD.

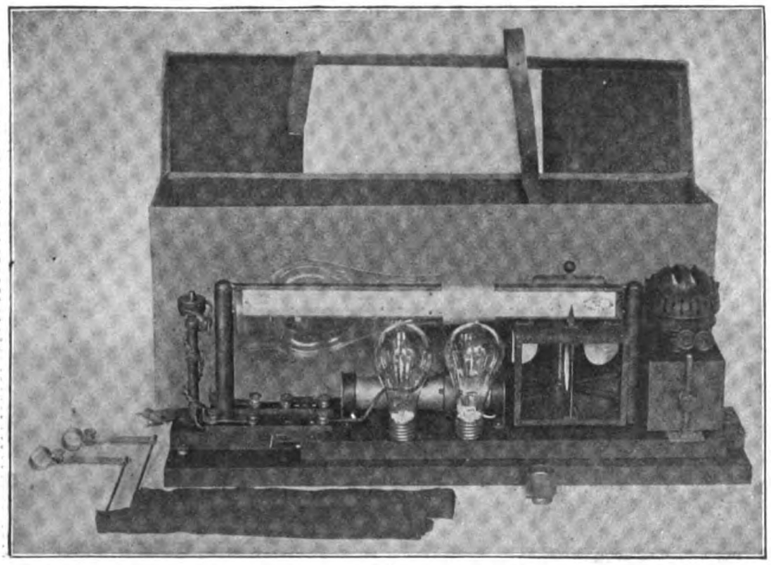
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Central Station Type Portable Photometer. Folded—ready to pack in carrying case.

An Instrument especially designed to meet the requirements of Modern Central Station Practice.

**New in Principle!**
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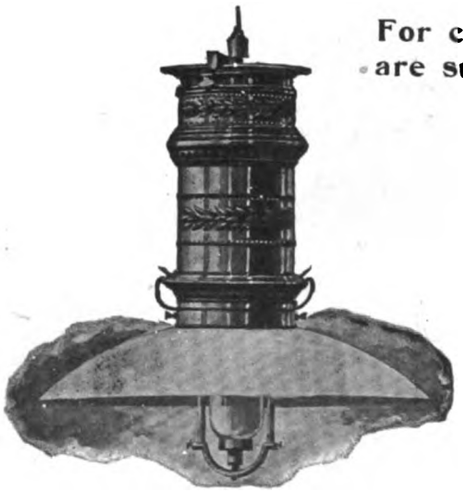
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Indorsed by all the Leading Lamp Manufacturers and used by their Salesmen as well as by Hundreds of Electric Lighting Plants, Engineers, and Technical Schools in all parts of the United States and Europe.

We are also HEADQUARTERS for Everything in the line of HIGH GRADE Electrically Illuminated Signs.
Commutating and Automatic Time Switches.

**The Electric Motor & Equipment Company,**
SUCCESSORS TO
Newark Ornamental Iron & Sign Works,
12-14 Beaver Street, - NEWARK, N. J.

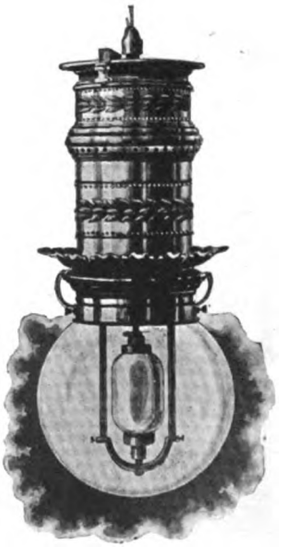
# The MORRIS ENCLOSED ARC LAMPS



For constant Potential Circuits are superior in points of

**Simplicity,
Economy,
Elegance,
Light.**

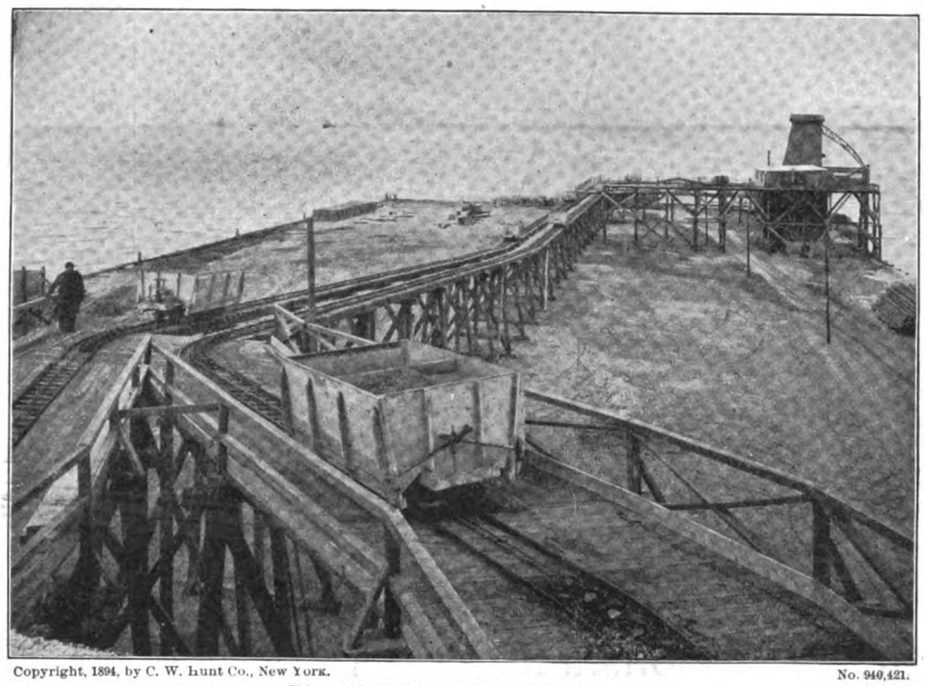
*You should look at them at the Exhibition.*



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As seen from the Coal Pocket at the South Brooklyn Power Station of the Brooklyn Heights Railway Co.

# THE HUNT SYSTEM OF COAL HANDLING IN POWER STATIONS

**We build three varieties of Cable Railways:**

**1. Heavy Cable Railway.** The steel cables run constantly, and the cars are attached at will at any point and are drawn around the tracks by the cable until the grip is released

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We have been in this special line of business since 1872 (27 years), and our coal-handling machinery is in use in almost every port of America, and in almost every country in the world. We have ample shops and capital, and manufacture everything we sell, thus we have control over both the quality of material and workmanship that otherwise we could not have. We design and make plans for all classes of wharves, trestels and storage buildings for storing coal and ore, and similar materials.

Write us your requirements. Our catalogues are free to interested parties. Address the works direct.

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## Direct Current Open Arc Lamps,
## Direct Current Enclosed Arc Lamps.

QUALITY UNEXCELLED. PRICES LOW. SAMPLES FREE.

We guarantee these Carbons to be more uniform and true to gauge than any other carbon of this character heretofore produced. . . .

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All Sizes. All Kinds.

## Enclosed Arc Lamps.

Direct Current, Constant Potential, Series,

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Long Life.

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Self-Lubricating, Non-Heating, Smooth Wearing.

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Alkalies, Nickel, Gold, Silver, Zinc, Metals.

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WE MAKE WHAT YOU WANT.

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Only Company outside the combination.

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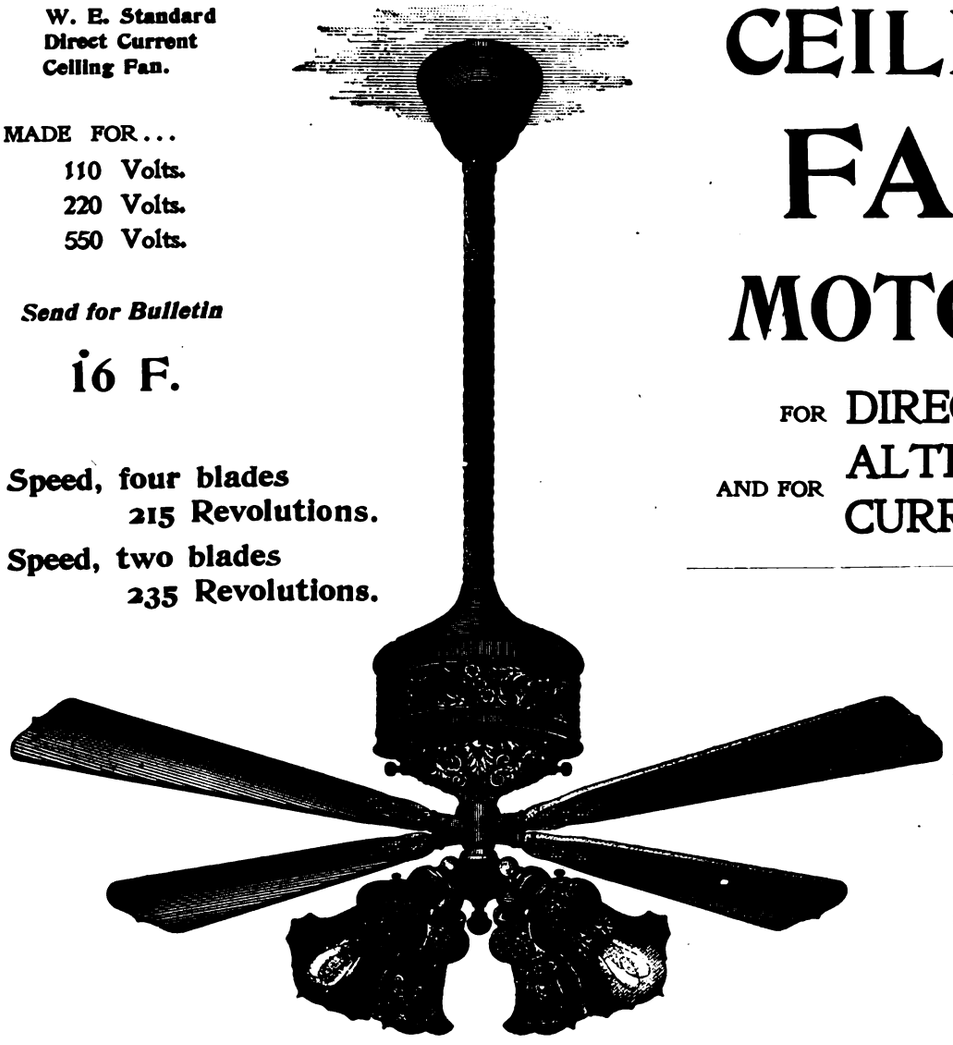
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Direct Current
Ceiling Fan.

MADE FOR...
110 Volts.
220 Volts.
550 Volts.

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16 F.

Speed, four blades
215 Revolutions.
Speed, two blades
235 Revolutions.



W. E. STANDARD CEILING FAN MOTOR.
Sweep of Blades 60 inches.

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FOR DIRECT
AND FOR ALTERNATING CURRENT.

Different conditions require Motors of different design.

**Bulletin 16 F.** describes the standard ceiling fan motor for direct current.

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**Bulletin 18 F.** describes the alternating current ceiling and desk fans.

**Bulletin 19 F.** describes our special Arctic ceiling fan for direct current—and wall switch rheostats for controlling speeds of any fans.

SUPERIOR MERIT AND REASONABLE PRICES
their recommendation.

WRITE FOR OUR 1899 FAN MOTOR CATALOGUE.

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Electric Light and Power Apparatus, Telegraph and Measuring Instruments,
Wire, Cable, Annunciators, Bells, Batteries, Arc and
Incandescent Lamps, Electric Light Supplies.

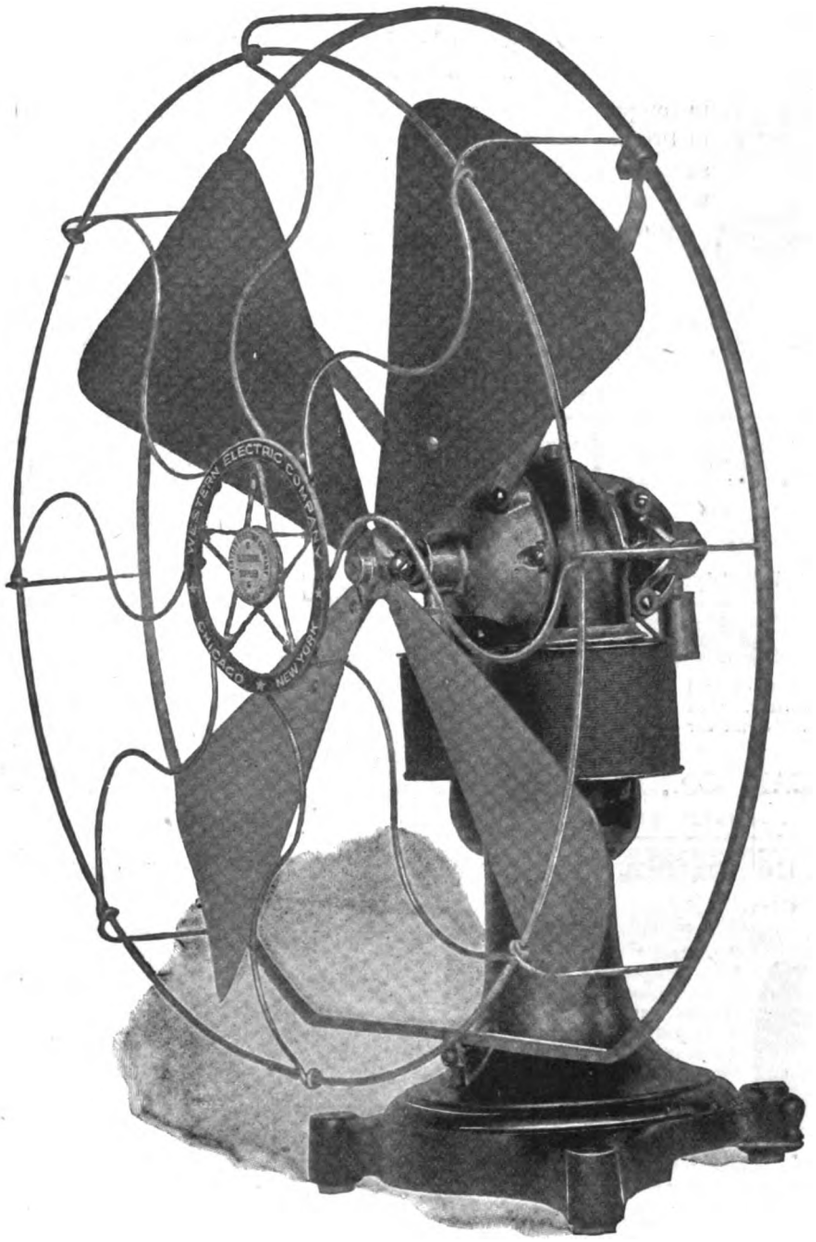
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DESK FAN MOTOR, SIXTEEN INCH.

# FAN MOTORS.

The W. E. Desk and Bracket Fan Motors are made in two sizes, viz.: 12 inch and 16 inch. The 12 inch fans are designed for 110 volts only. The 16 inch fans are designed for 110, 220 and 550 volts. All sizes of Desk and Bracket Fans have three speeds.

The W. E. Standard Ceiling Fan Motor has four blades, and is designed for 110, 220 or 550-volt circuits. It has three speeds; the controlling switch is in the base of the motor. These fans also have chandelier attachments.

SPEED FOUR BLADES 215 R. P. M.
TWO BLADES 235 R. P. M.

The Arctic Ceiling Fans have four blades, and are designed for 110-volt circuits only, but can be run 2 in series on 220 volts, or 5 in series on 550 volts. They are designed with one speed and have no controlling or starting switch in the motor.

SPEED 170 R. P. M.

By using our Special Wall Switch Rheostat the Arctic Fans may be run at three speeds. The Special Wall Switch Rheostat may also be used for any one fan, or series of fans, to control and regulate their speed.

## Our 1899 Fan Motor Catalogue

DESCRIBES IN DETAIL THE FAN MOTORS OF OUR MANUFACTURE.

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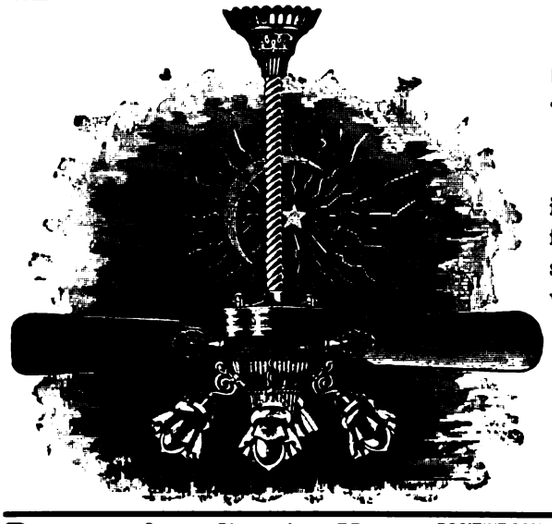
MANUFACTURERS AND DEALERS.

**Electric Light and Power Apparatus, Arc and Incandescent Lamps, Telegraph and Measuring Instruments, Wire, Cables, Annunciators, Bells, Batteries and Electric Light Supplies.**

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*WE WILL PLACE OUR*

**Ceiling and Desk Fans**

in competition with any other manufactured. Our new Type Desk Fan, supplied with improved wing, is a winner.

Address all communications to the

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MARIETTA, PA.



**Reversing Controllers.** POSITIVE CAM MOVEMENT, LONG ARCING DISTANCES, IMPROVED CONTACTS, FIRE PROOF RESISTANCE

FLOAT SWITCHES, SPECIAL SWITCHES, SOLENOIDS

Resistance Coils for Special Duty. Switchboards.

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**VITRO CHROME**

An indestructible Incandescent Lamp Color. Equal to natural glass in appearance and durability. Can be used for inside or outside decoration. Send for circular and prices.

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**McCREARY'S Patented HALF REFLECTOR SHADES.**

Glass, Aluminum, Tin.



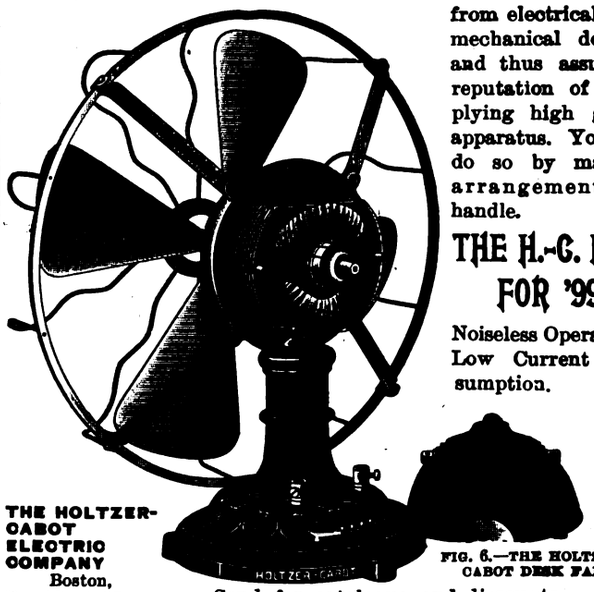
Opal, Red, Blue, Crystal, Green, Yellow, Silvered Glass, Green & Opal, Aluminum, Tin.

For 16 or 32 C. P. Lamps.

NEW LIST AND DISCOUNTS.

**A. A. McCREARY,** 136 Liberty St., NEW YORK.

You should give your customers **A FAN MOTOR FREE** from electrical and mechanical defects and thus assure a reputation of supplying high grade apparatus. You can do so by making arrangements to handle.



**THE H.-C. FAN FOR '99.**

Noiseless Operation
Low Current Consumption.

THE HOLTZER-CABOT ELECTRIC COMPANY Boston, Brookline), Mass.

FIG. 6.—THE HOLTZER-CABOT DESK FAN.

Send for catalogue and discounts.

When Writing to Advertisers Please Mention The American Electrician

**TRIUMPH EXHAUST FAN.**

*Guaranteed to Move*

More Air, Dust, Heat, Steam, Etc.,

with Less Power Than Any Other Fan.



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**ALL KINDS OF FANS, also WATER MOTORS.**

Most Economical Water Consumption.

**JUNIOR WATER BLOW FAN.**

Only Successful Water Blow Fan.

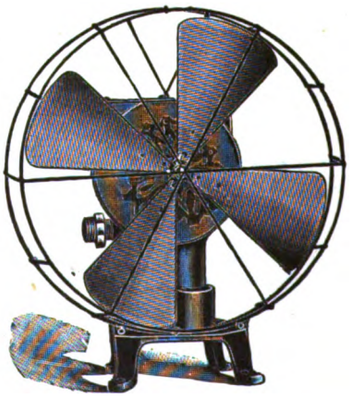
State Water Pressure.

FLIES HAVE NO USE FOR THEM.

*Attractive, Efficient, Durable.*

List Price,

**$7.50.**



PATENT APPLIED FOR.

**SPECIALTY MFG. CO.** 361 to 367 S. Meridian St., INDIANAPOLIS, IND.


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# A NEW FAN MOTOR

## PEERLESS



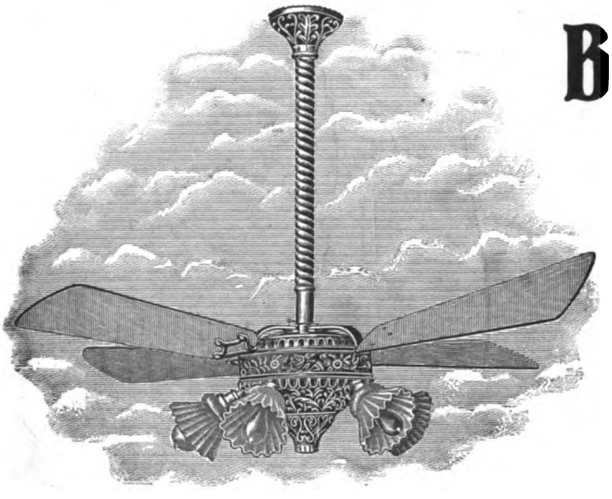
It's a beauty, and guaranteed 20 per cent more efficient than any on the market. Think of a 12" fan running 1850 revolutions per minute with only 35 watts. Price is right also.

*AGENCIES WANTED*

**The Warren Electric & Specialty Co.**

*WARREN, OHIO*

Manufacturers of *PEERLESS* { *Incandescent Lamps, Fan Motors, Transformers*



# Bates Electric Fans

**UNEXCELLED.**



## NEW DESIGNS.

**Ceiling and Desk.**
**Any Voltage.**
**Direct or Alternating.**

**D. L. BATES & BRO., - - Dayton, Ohio.**

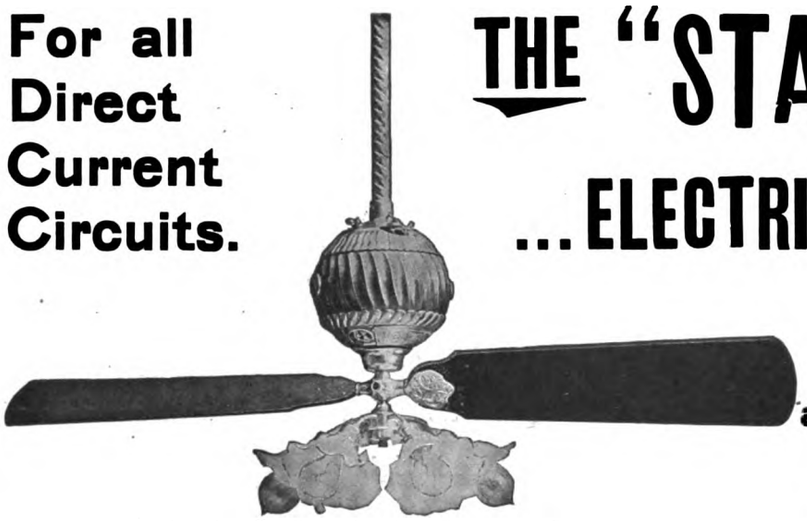

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For all Direct Current Circuits.

# THE "STANDARD"

## ...ELECTRIC FANS...

Ceiling and Desk or Bracket



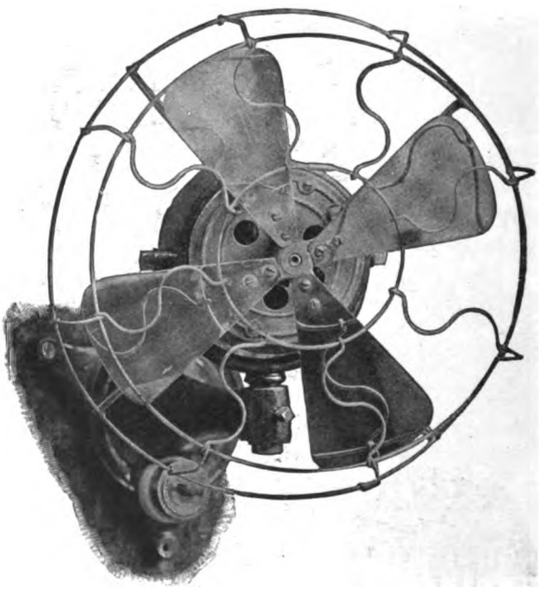
Style "A" Electrolier Fan with Switch.

**Our CEILING FANS** need no introduction. They do all we or our agents claim for them, and the result is not excelled. Notice the **Electrolier** and **Switch** Attachment. They fill the demand. **Ball Bearing—Self-Oiling (and does not drip oil)—Noiseless—Most Breeze—Best Results**—are a few of the exclusive features we claim.

## Our SEARCH-LIGHT FANS

for either Desk or Bracket can be adjusted to any desired position. Same base for either, but angle socket furnished with wall bracket.

. The Fan is **built from the ground up,** and has advantageous features that no other fan has.



Standard Search-Light Fan.

**FINISH—Superb Black Enamel with Heavily Nickeled Trimmings.**

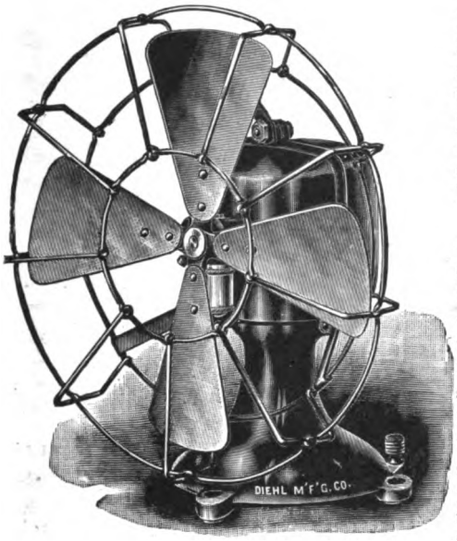
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**THE ROBBINS & MYERS CO., Springfield, Ohio, U. S. A.**


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# DIEHL ELECTRIC FANS

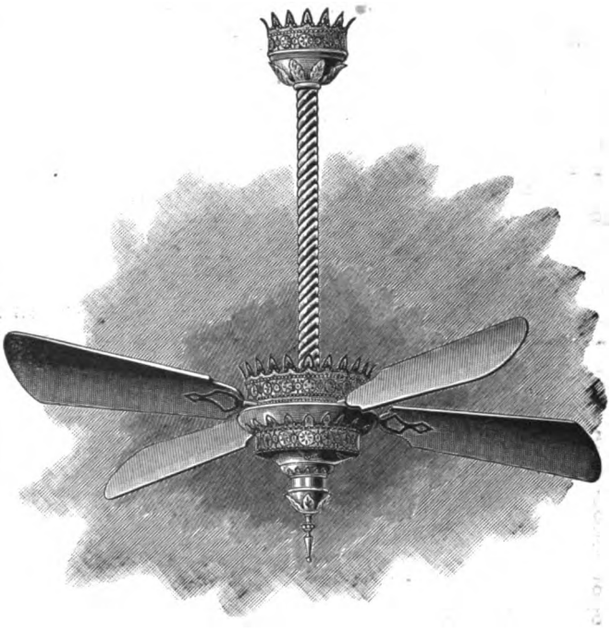
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Our line of Electric Fans for ALL purposes for the present season is the most complete that we have ever placed on the market, and the high standard of our product has been strictly upheld.

Our Fans are the cheapest because they are absolutely the best made, wear longest, require less outlay for repairs and show a higher efficiency than any other fan. This statement is fully sustained by the past record of our fans. Our place has always been in the lead and we intend to maintain that position.



## DIEHL MANUFACTURING CO.

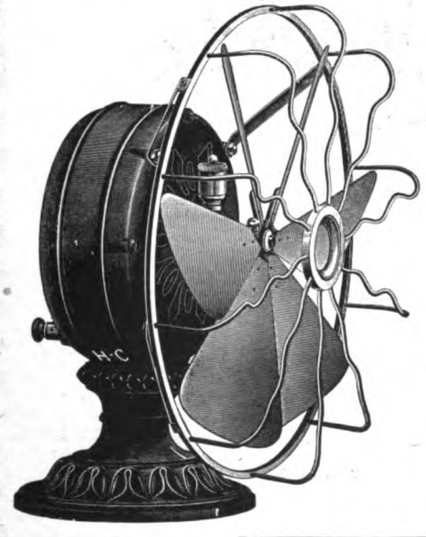
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128-132 Essex St., BOSTON.

MAIN OFFICE AND WORKS,
ELIZABETHPORT, N. J.

Superior Quality At Low Prices

## J. Jones & Son

Anything In the Electrical Line



## Electric Fans

BATTERY, ALTERNATING and DIRECT CURRENT FANS.

Desk, Ceiling and Bracket, All Styles, All Finishes.

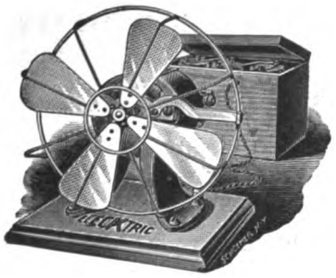
J. JONES & SON,
60 Cortlandt Street,
Factory, Brooklyn. New York City.

BATTERY FAN OUTFITS—In a Nice Case.

10 inch Fan, with 6 cells of Edison-Leland Battery, - - - - $15.00
8 " " 4 " " " - - - - 10.00
10 inch, guaranteed to run 125 hours. 8 inch, guaranteed to run 100 hours.

60 CORTLANDT ST. NEW YORK.


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# Happy Dealers

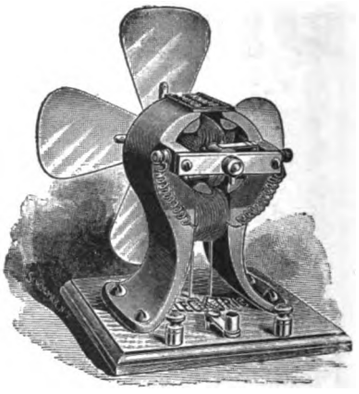
when handling satisfactory, reliable and profitable goods.

# Happy Consumer

when using such goods.

# Knapp Battery Motors

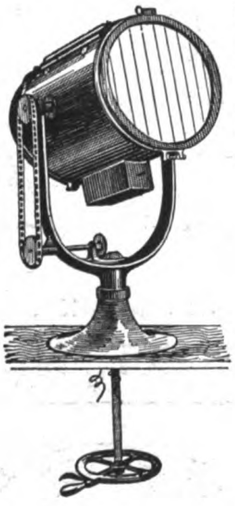
known the world over. Types C & D universally used for driving 8 inch and 10 inch



**FANS.** If you want the latest, see that these two sizes are fitted with spring adjustable brushes, allowing the finest adjustment while running. Other sizes for other purposes.

**Knapp Electric and Novelty Co.,** 129 WHITE STREET, NEW YORK.

**Manufacturers of Specialties.** **Goods made under Contract.** **Experimental Work.**



# Projectors and Search Lights

*IN ALL SIZES,*
*10 TO 100 AMPERES.*

PILOT HOUSE
AND
DECK LIGHTS.

ENGLISH NAVAL or MANGIN MIRRORS

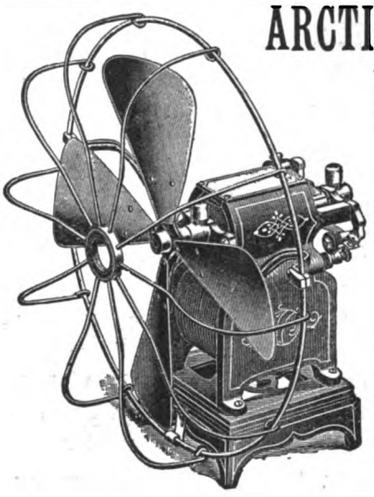
**Complete Marine Electric Equipments.**

Write for Estimates and Prices.

## CHAS. J. BOGUE,

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# ARCTIC BATTERY FAN MOTORS.

**Every Motor Sold is Guaranteed.**

**Patented Brush Holders, Binding Post, Switch and Brackets.**

Write for Catalogue and trade discounts.

**BATTERY OUTFITS COMPLETE**
**4½ to 12 in. Fans, $4 to $20.50.**

**Our Motors are built of the best Material and are mechanically and electrically perfect.**

**JOHN E. FULLER,**
*Electric Specialties,*
93-95 Malden Lane, New York City

**HAVE YOU RECEIVED OUR**

# 1899 Fan Motor Catalogue?

**IF NOT**

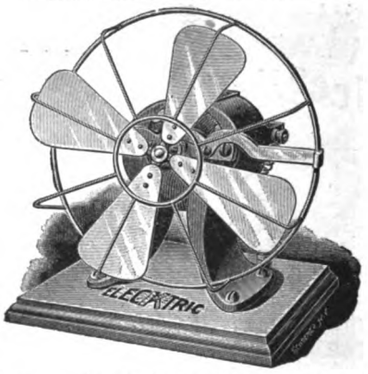
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## THE EMERSON ELECTRIC MFG. CO,

**ST. LOUIS, MO.**

# Gordon Fan Motor Outfits.

***CHEAPEST AND BEST.***



TYPES { B Motor, with 6-inch fan, with two or three Gordon cells.
C Motor, with 8-inch fan, with three or four cells.
D Motor, with 10-inch fan, with four or five cells.

**Highest speed at lowest cost from primary cells.**

***Outfits from $12 to $27.50,***

**According to type and number of cells.**

**The Gordon Cells are guaranteed.**

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**GORDON BATTERY CO.,** 594 Broadway, New York City.

FACTORY, CRANFORD, N. J.


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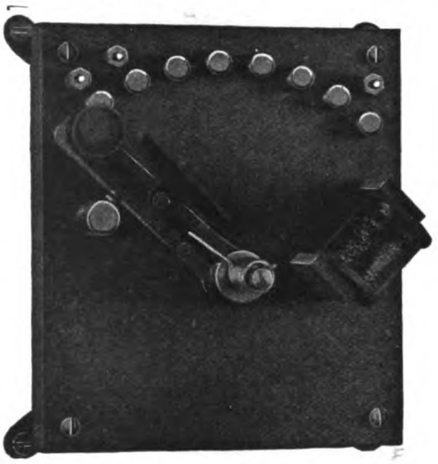
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## CIRCUIT BREAKERS AND RHEOSTATS

PERFECT WORKMANSHIP

HIGHEST FINISH

Motor Starter with Automatic Release.



"SU" TPYE.

3 H·P·SIZE·····PRICE, $4·50

GREATEST RELIABILITY & SIMPLICITY

EASE AND CHEAPNESS OF REPAIR

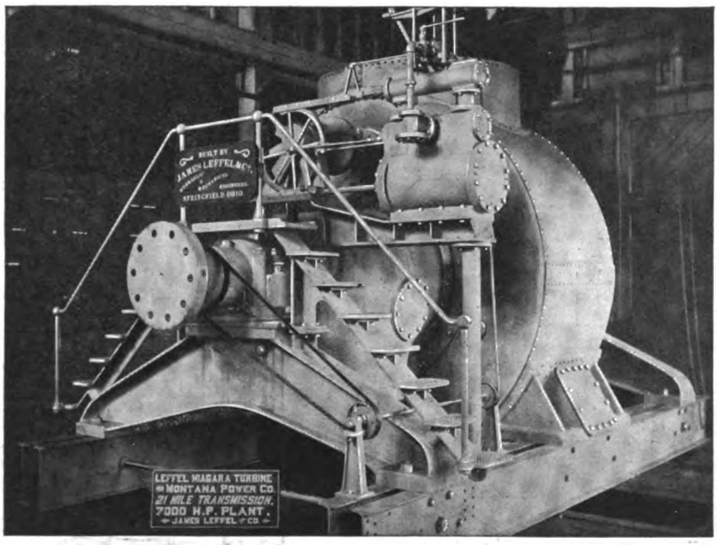
THE STANDARD OF EUROPE AND AMERICA

WARD LEONARD ELECTRIC CO.,
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# LEFFEL WATER WHEELS




FOR HEADS FROM

3 FEET to 2000 FEET.

*ADAPTED TO ALL KINDS OF*

**Electric Lighting, Street Car and Power Plants.**

Special features such as their **High Speed and Efficiency, Strength, Fine Regulation and Steadiness of Motion**

MAKE THEM HIGHLY DESIRABLE FOR

**Direct Couple to Generators.**

# Leffel Automatic Engines,

FROM

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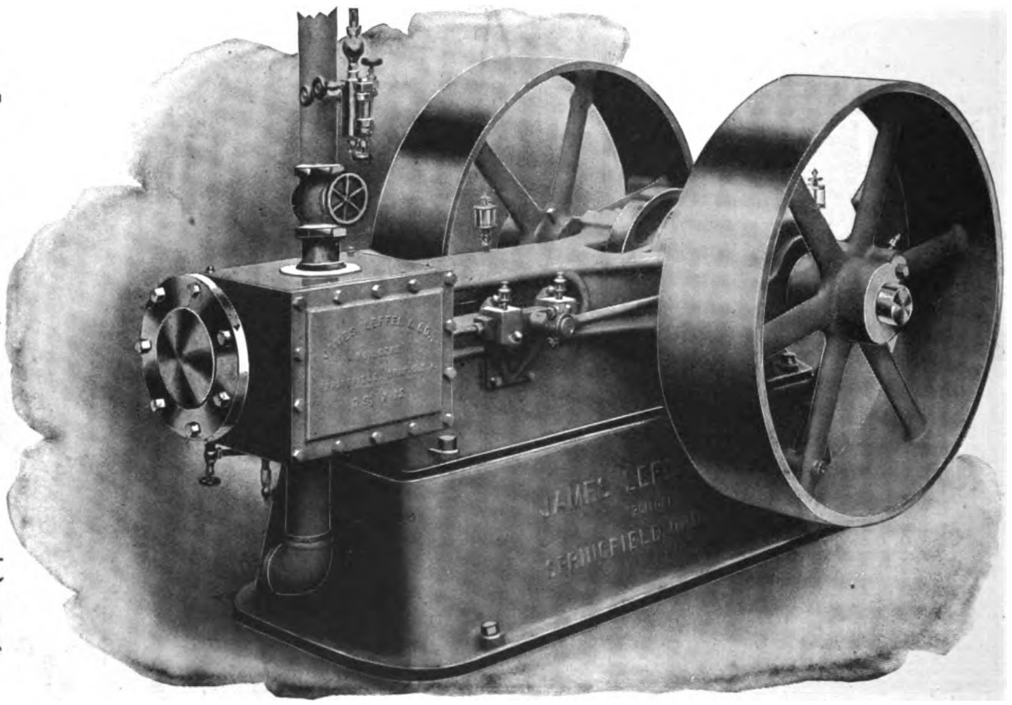
EQUIPPED WITH

***Finest Governing System.***

**Afford best possible Regulation, with highest economy in Steam.**

PARTICULARLY WELL ADAPTED FOR

**Electric Light and Power.**



Pamphlet of Water Wheels or Engines sent on application, stating which and what is wanted.

## JAMES LEFFEL & CO.,

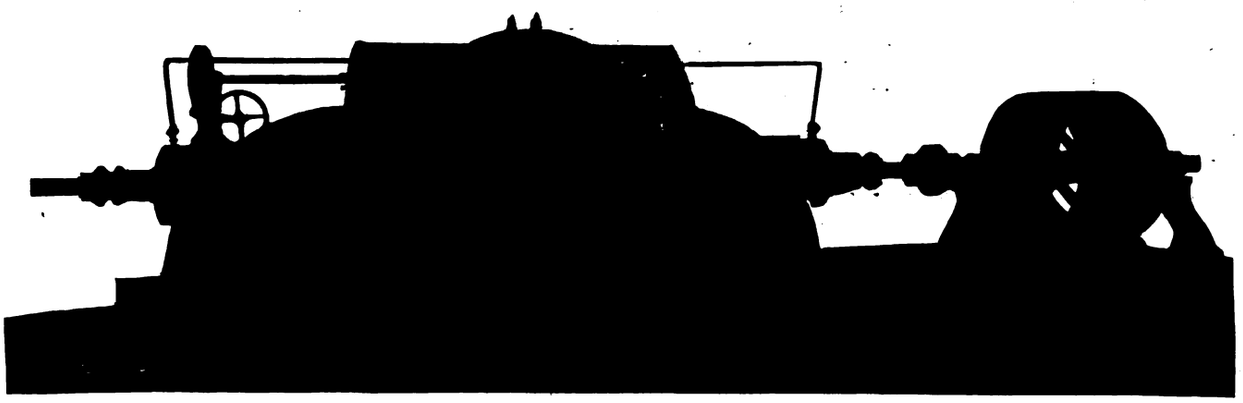
**SPRINGFIELD, - - - - - - OHIO, U. S. A.**


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# Efficiency, Steadiness and Easy Regulation

ARE THE DISTINGUISHING FEATURES OF THE

# NEW AMERICAN TURBINE.



The above illustration shows a representative outfit for an installation of a pair of turbines under a high head. By this arrangement are obtained the lowest cost and the greatest strength and rigidity.

Lowest cost, because requiring the smallest dimensions of all its elements, to receive and discharge the required amount of water.

Greatest strength and rigidity, because the quarter turns at the ends brace and support the flume, and the steps in the ends of the quarter turns take up all "end thrust" of the wheel shafts.

Long experience in building turbines enables us to guarantee economy in design and efficiency in results.

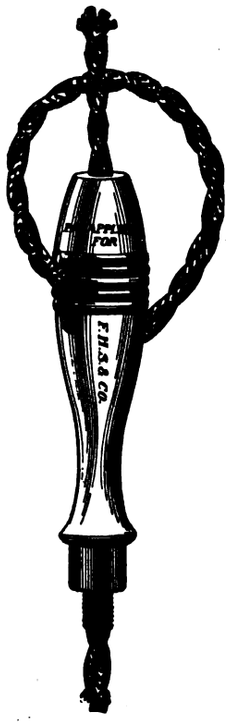
**The Greatest Power for a Given Diameter and the Highest Average Efficiency from Whole to Half Water of Any Wheel on the Market. The Most Simple and Durable Construction.**

MANUFACTURED BY

## THE DAYTON GLOBE IRON WORKS CO.,

DAYTON, OHIO, U. S. A.


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# THE STEWART

## Combination Socket Handle and Cord Adjuster.

**THIS IS IT!**

"Why didn't I think of it?"

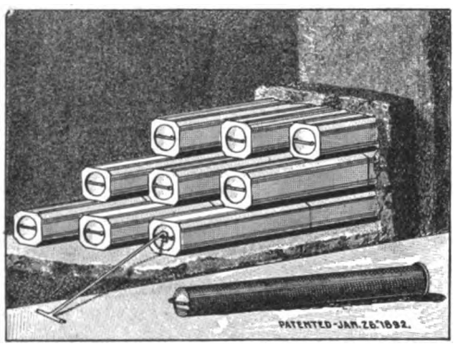
Takes all strain from socket.
Saves price of adjusting ball.
Adjustment always within reach.
Has metal thread to fit all standard sockets.
Takes any size cord.
Your customers will want it.




## FRANK H. STEWART & CO.,

Corner Seventh and Filbert, - - - PHILADELPHIA.

# The H. B. Camp Co.'s Vitrified Clay Conduit.




**For Underground Telephone, Telegraph and Electric Light Wires and Underground Trolley System for Electric Street Railways.**

MANUFACTURED BY **THE H. B. CAMP CO., Aultman, O.**

Our conduit is made of specially prepared clays, is thoroughly vitreous and glazed, making it acid, gas and water proof, and is not affected by electrolysis. Standard size is 3 inch internal diameter. However, we can make any size or multiple duct. Our patent mandrel used in laying our conduits prevents the possibility of shoulders, and insures good alignment of bore. We claim for strength, economy, durability, cheapness and perfect insulation it is the best, and is used by the most prominent companies. Any information promptly given.

Write for catalogue.

**THE H. B. CAMP COMPANY,**
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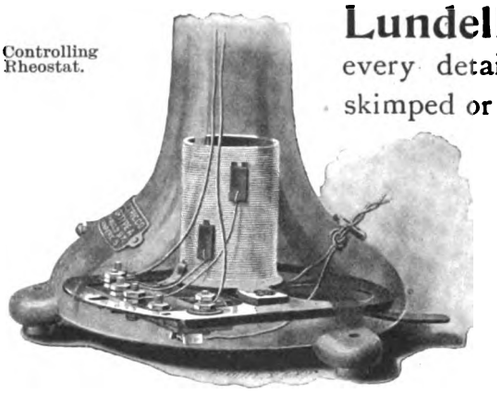
HAVE USED **NEW STANDARD BATTERIES**

in the late war for rapid fire guns with well-known success.

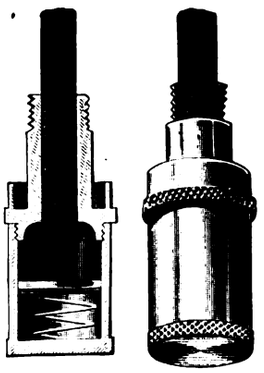
Telephone Companies, Supply Dealers, and other users of Dry Batteries are equally enthusiastic of the service obtained from our goods, and agree with our claim of a superiority of 4 to 1 over any other make. **Note Change of Address.**

**WM. ROCHE, - - - 42 Vesey Street, New York.**


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Controlling Rheostat.

**Lundell Fan Motors** are complete and perfect in every detail. Not a single feature of construction has been skimped or neglected. From the smallest screw, to the drop-forged field frames, the workmanship and finish is *perfect*. **The enamel rheostat,** concealed in the base (original with us and diligently imitated by every other maker) is the best device made for this purpose, giving three distinct and widely varying speeds.



This rheostat is far superior to the clumsy affairs generally used. It is mounted on a punched steel base, securing lightness, rigidity and freedom from the breakage incident to porcelain bases.

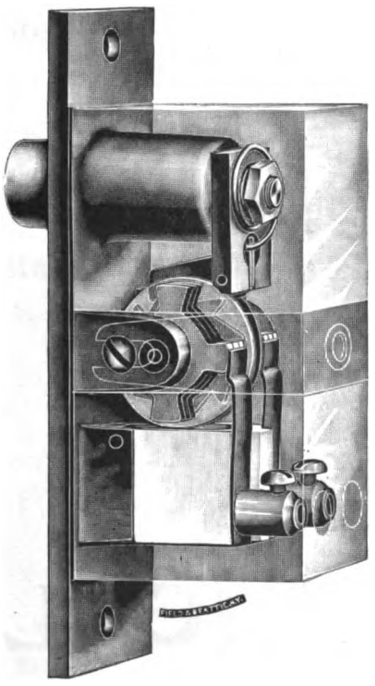
**The Oil Cups** of the Lundell are the only ones that can be *depended on* to keep the bearings lubricated the entire season without attention. There is no comparison between these cups and cheap grease pots. **Everything considered** the Lundell is the finest and most satisfactory fan motor made, and the most profitable one for Dealers, Contractors and Central Stations to handle. June is the month for business; *will you get your share?* Write for Catalogue 661 if not already supplied.

CHICAGO, Fisher Building.

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**Send for New Catalogue (3d Edition) of Electrical Books.**

# THE ECO DOOR SWITCH
## MAKES Contact Every Other Time



APPROVED BY

**National Board of Fire Underwriters.**

When the door is shut—**NO LIGHT!**
Open it to go in—**LIGHT!**
Shut it after you are in—**STILL LIGHT!**
Open it to go out—**NO LIGHT!**
Shut it after you are out—**STILL NO LIGHT!**

SIZE OVER ALL

3¾ in. LONG, 1 in. WIDE, 1⅝ in. DEEP.

# EDWARDS & CO.,

NEW YORK, N. Y., U. S. A.

A. Lüngen.


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# APPARATUS DEPARTMENT.

*...Exclusive Territorial Sales Agents...*

FOR

# WARREN ALTERNATORS.

See Page 86.

# EDDY DIRECT CURRENT MACHINERY.

See Page 87.

# MALONEY TRANSFORMERS.

See Page 42.

# ADAMS BAGNALL ARC LAMPS.

See Page 15.

***WRITE US FOR BULLETINS AND PRICES.***

# WESTERN ELECTRICAL

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## ...*Exclusive Territorial Representatives*...

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**Electric Railway Material and Supplies of Every Description.**

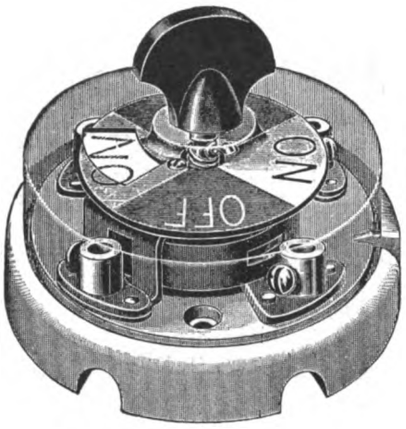
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# SUPPLY COMPANY,

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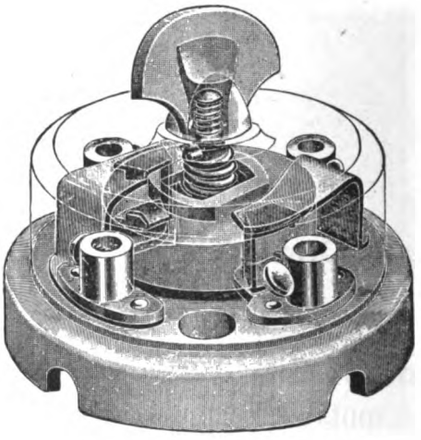
# LIGHTING



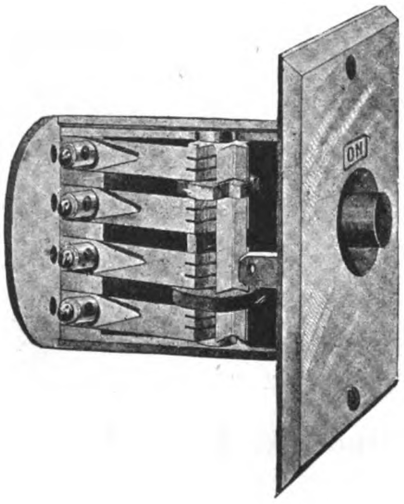

Large and Assorted Stock of

## SWITCHES

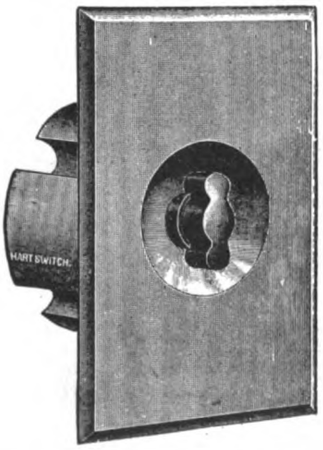
of every description.



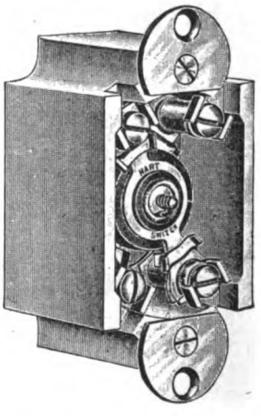
We can make Prompt Shipment of any Standard Switch desired.




Our Stock is Complete in every detail and our Prices all right.




Pocket Catalogues devoted exclusively to Switches will be sent on application.

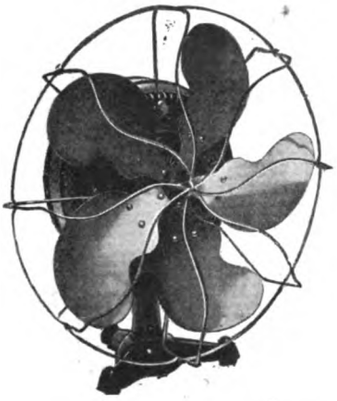


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10 & 12 NORTH NINTH STREET,

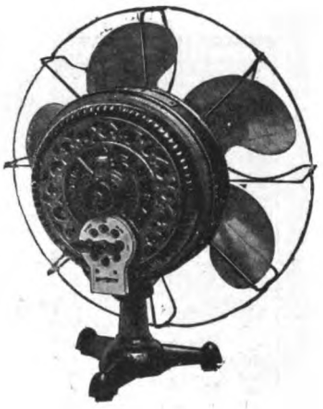

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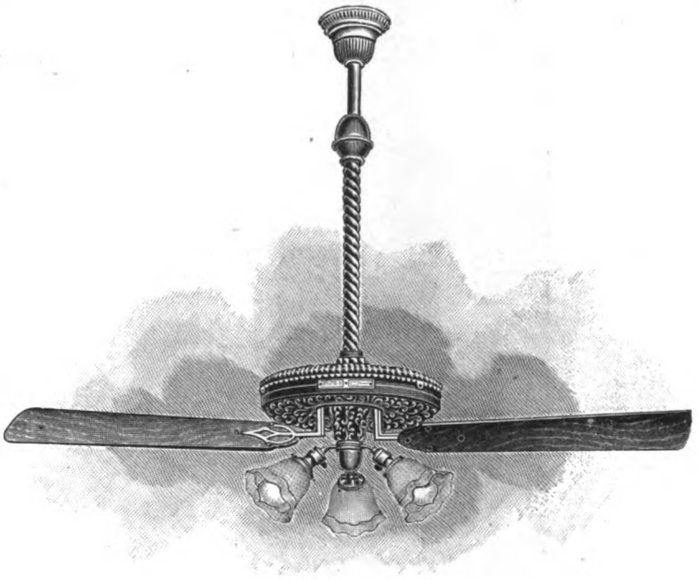
# DEPARTMENT.

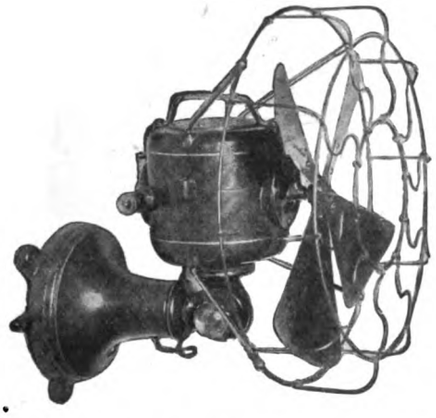


## *Emerson...*

**Alternating Current, Desk, Bracket and Ceiling Fans.**







## *Paragon...*

**Direct Current, Desk, Bracket and Ceiling Fans.**

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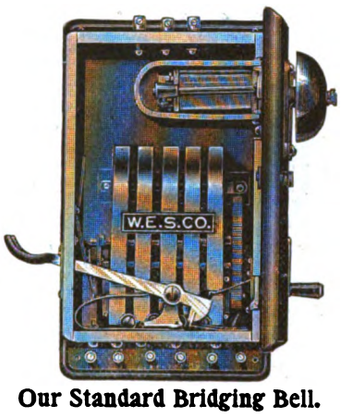
# SUPPLY COMPANY,

ST. LOUIS, MO., U. S. A.

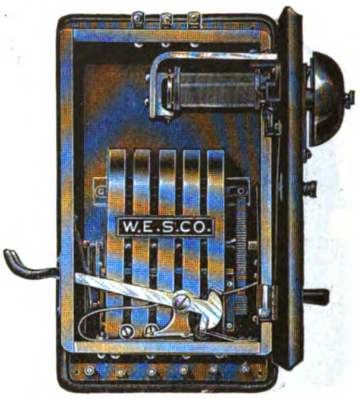

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# TELEPHONE DEPARTMENT.

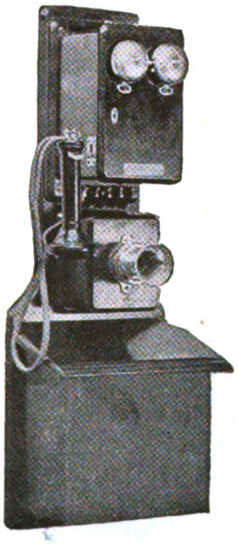
## We Equip your Exchange Complete.

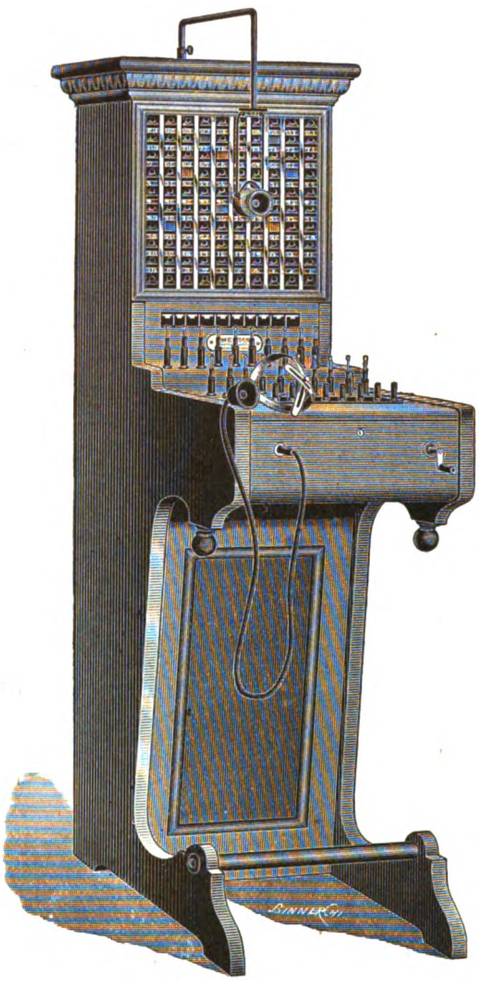



**Our Standard Bridging Bell.**
Nickel Plated throughout.

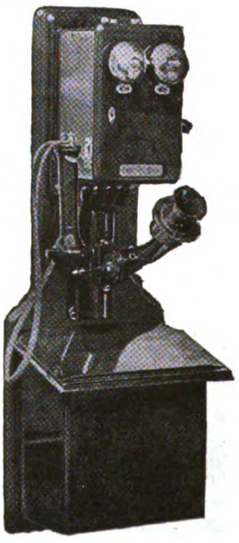



**Our Standard Series Bell.**
Nickel Plated throughout.





Perspective view of the New Western Express Switchboard equipped with one hundred combined removable jacks, drops and coils. This board contains many new features which, with those of the No. 1, makes it a model of the designer's art.



Our Telephone Equipment
Is the Equal of the Best
And is Excelled by None.

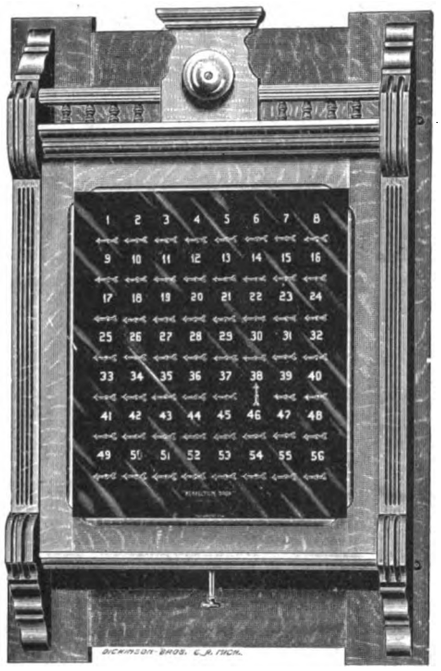
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# HOUSE GOODS DEPARTMENT

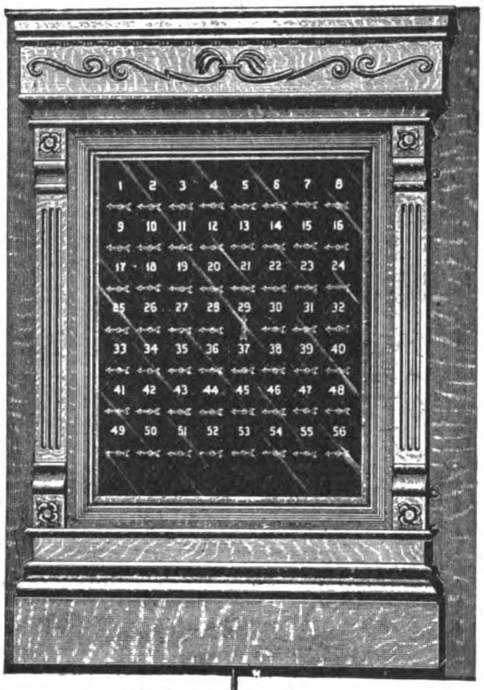
**Our Annunciators are Electrically and Mechanically Unequaled.**



Style G.



Style B.



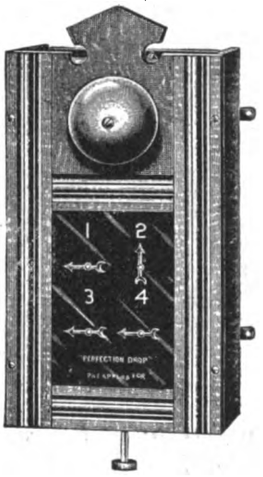
Style F.



Standard
Burglar Alarm.



Style D.



Standard
House Style E.

**Perfection in Name and Design.**

# SUPPLY COMPANY,

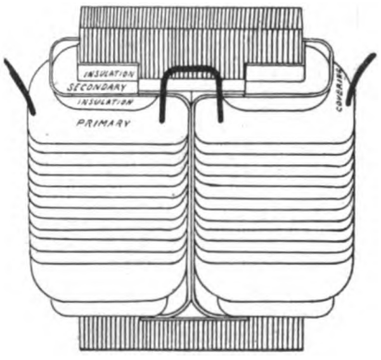
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# TRANSFORMERS.

We are Exclusive Manufacturers of Strictly

## High Grade Transformers.



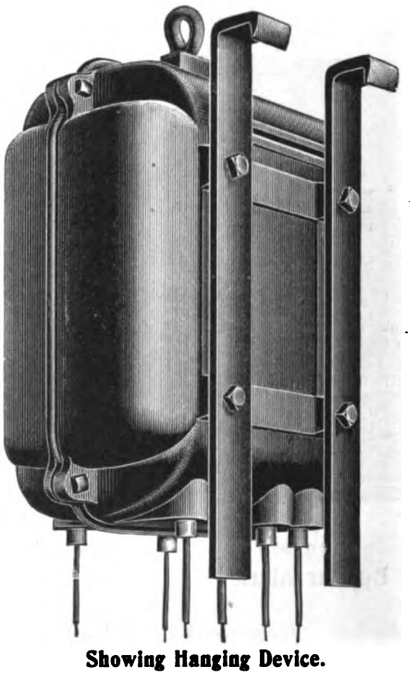

Showing Mechanical Construction.




Front View.

THE **superiority** of these instruments over other types is on account of a **lower percentage** of **losses** and a much greater **durability.**

Nearly all losses are obviated by the use of the best-known material and the durability obtained by the acme of mechanical construction.



Showing Hanging Device.

WE guarantee our transformers against **all burn-outs,** including lightning, for a **period of two years.**

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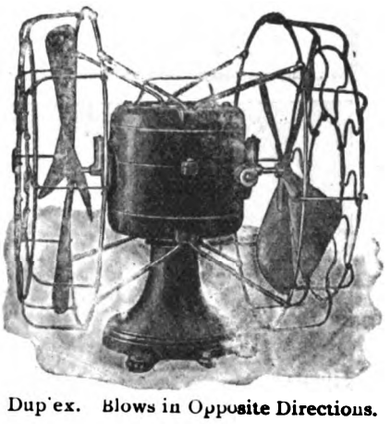
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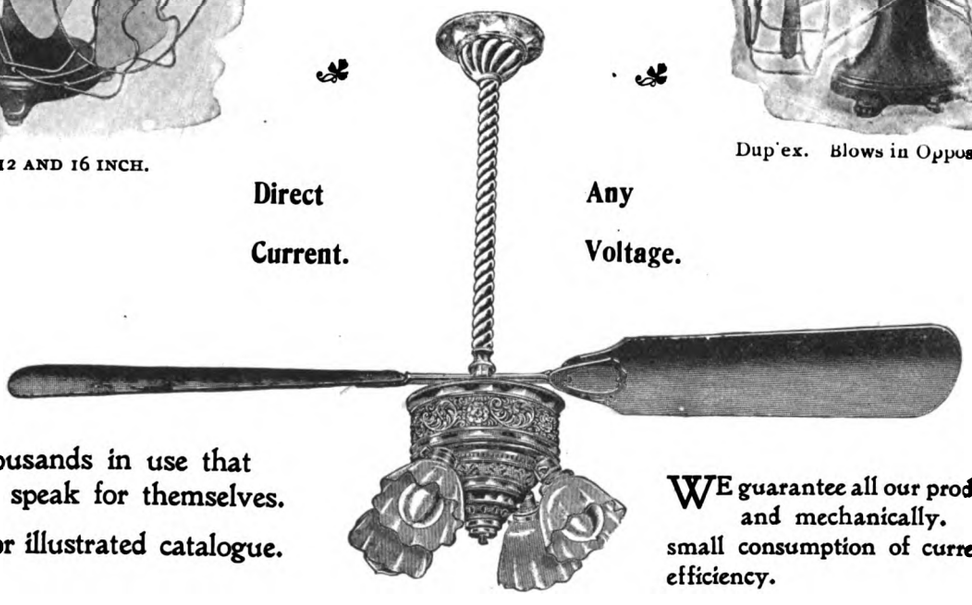
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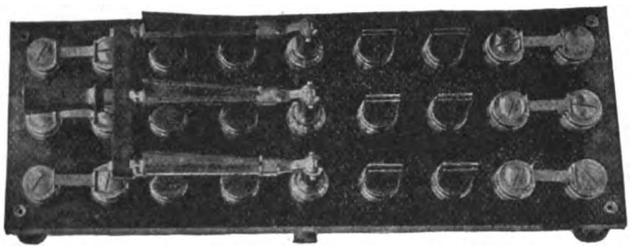


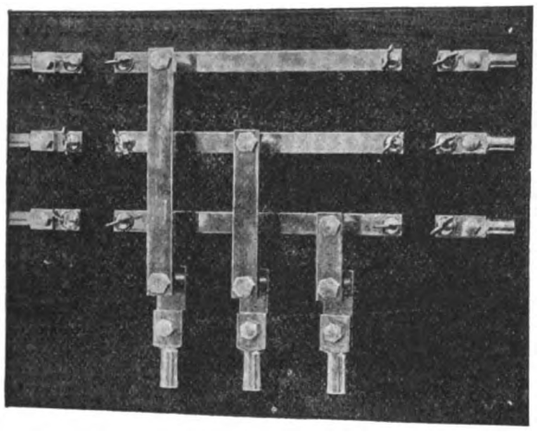
Thousands in use that speak for themselves.

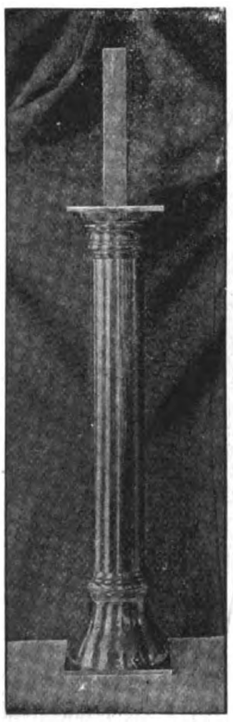
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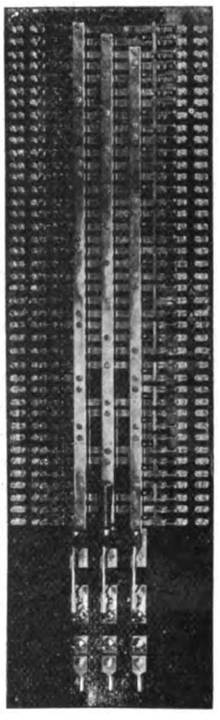
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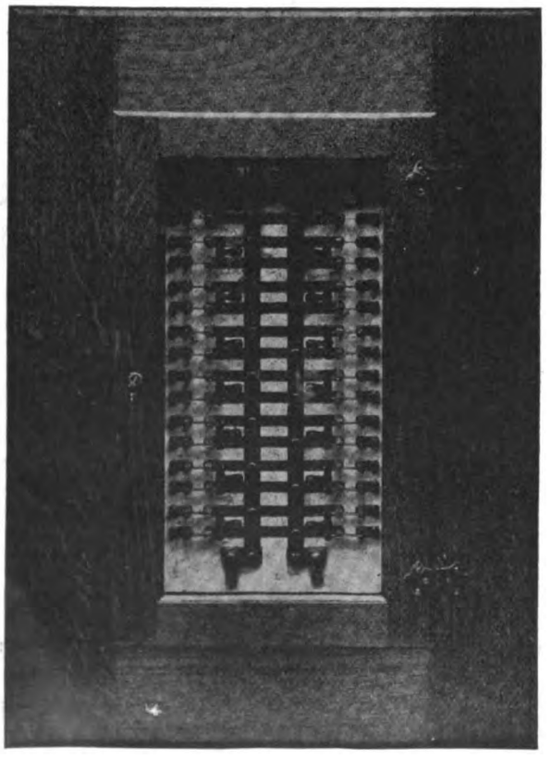


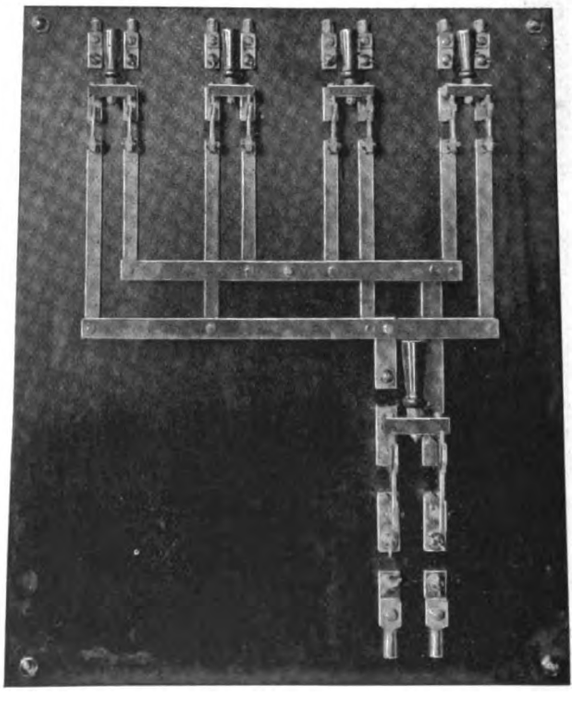


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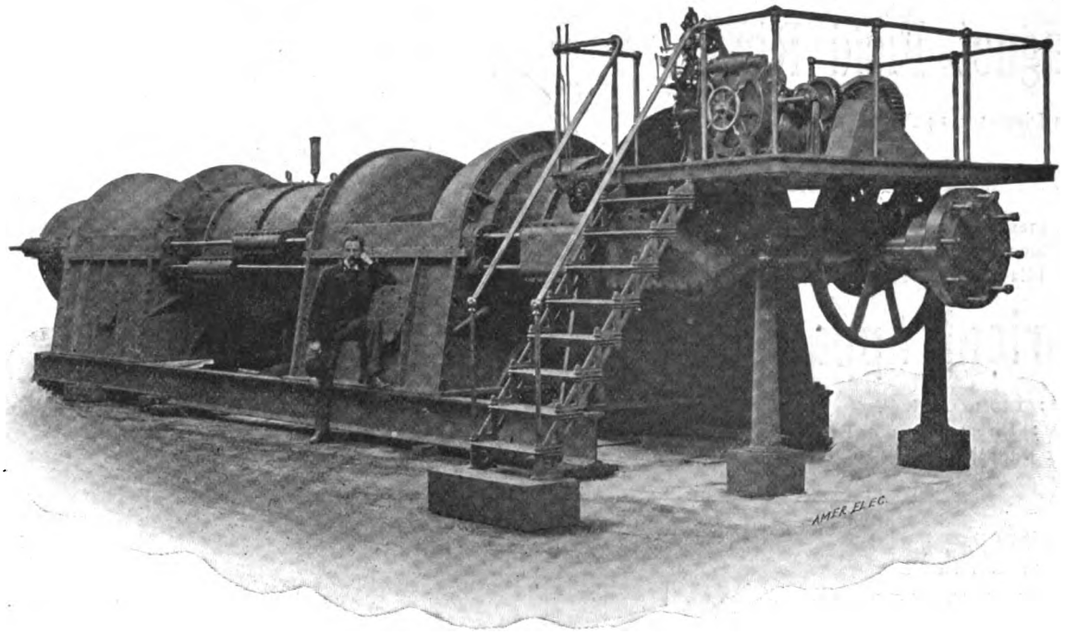





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These improvements mark the greatest advance of late years in this line of work. Among the numerous advantages gained we mention particularly the following:

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Wagner Electric Mfg. Co.

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S. A. Abadie Secretary.

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Voltage, 1.5x1.6.
Amperage, 8 to 10.

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Dimension, 1¾x4.
Weight, 12 ounces.
Voltage, 1.5.
Amperage, 4 to 6.

**No. 2.**
Dimension, 2½x6.
Weight, 1.7-10.
Voltage, 1.55.
Amperage, 6.8.

**No. 4.**
Dimension, 1¼x3.
Weight, 6½ inches.
Voltage, 1.5.
Amperage, 3 to 4.

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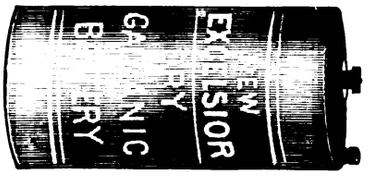


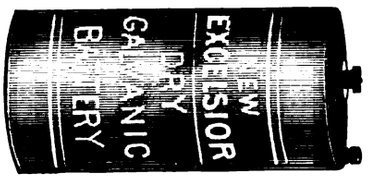


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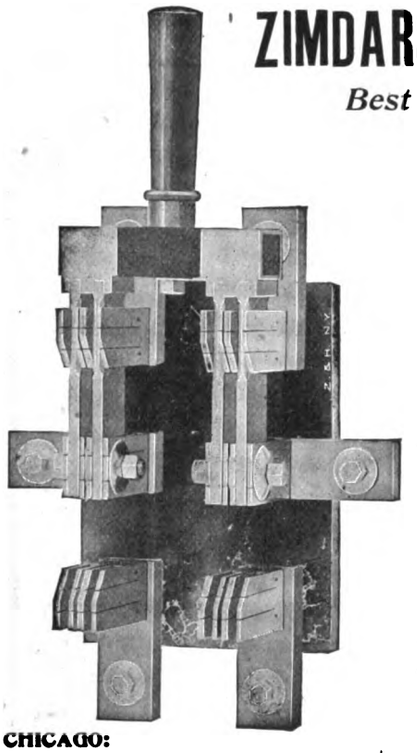

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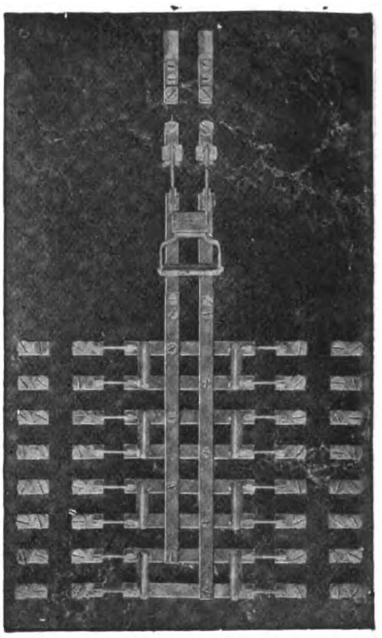
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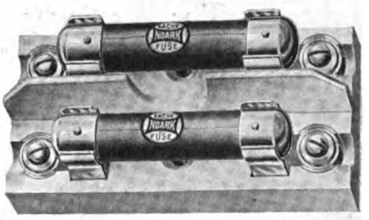
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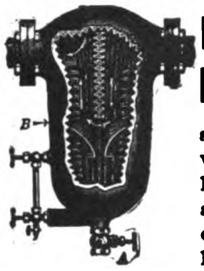
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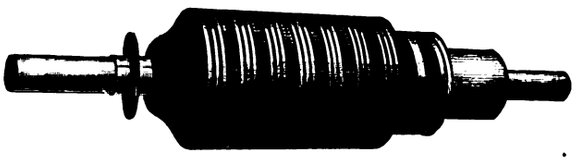

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One of two 175 K. W. No. 60 Edison Bipolar Armatures recently rewound and Commutators refilled by us. By our special system of winding we give these and other types of Armatures **Ventilated Ends.**

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WE desire to call your attention to our unequalled facilities for rewinding Arc Light Machines. If you contemplate changing your dynamos to secure an Enclosed Arc Lighting Service, we especially solicit your orders.



150 K. W. Westinghouse Commutator. | 1-8 H. P. Fan Motor Commutator.

Also, to our excellent facilities for handling heavy work. Having a large corps of expert winders, we are equally as well prepared to do work abroad, on armatures too large to ship, or on direct-connected machines, etc., as the manufacturers of same.

---

***PRICES QUOTED ON APPLICATION.***

# Van Dorn & Dutton Company,

**1796 East Madison Avenue,**

**TELEPHONE, EAST 475.** * **CLEVELAND, OHIO.**


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# THE PELTON

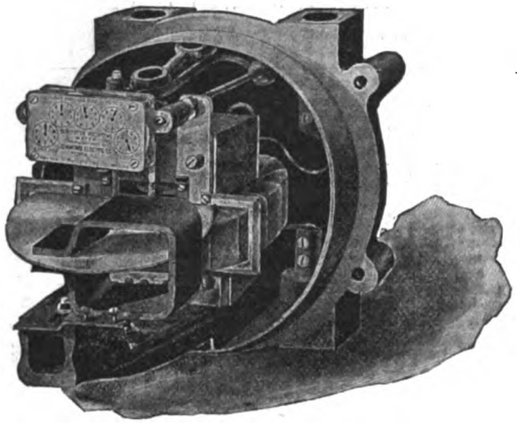
## CLEVELAND,



## Station Supplies & Machinery.

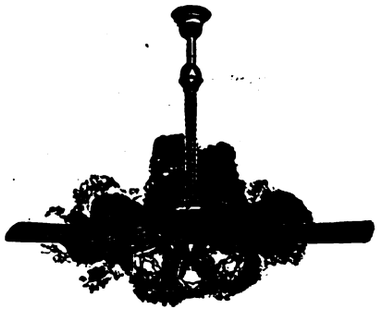
### Dynamos...

Motors,
Arc Lamps,
Incandescent Lamps,
Meters,
Transformers.



### Repairs...

Rewinding,
Commutator Work,
Lamps Rebuilt.



### Fan Motors...

Alternate Current,
Direct Current,
Water Power.

# THE PELTON

## CLEVELAND,


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# ENGINEERING CO.

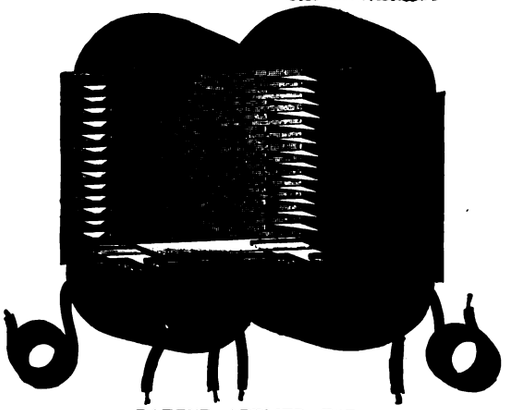
## OHIO.

## Second-Hand Machinery.



A 65 K. W., 500-volt Detroit Generator, with rheostat, main switch and circuit breaker. Overhauled and Warranted, $450.00

A 45 K. W. Edison Generator, 500 volts, late type of G. E. apparatus, with rheostat, main switch and circuit breaker. Fully warranted, - - - - $475.00



PATENT APPLIED FOR.

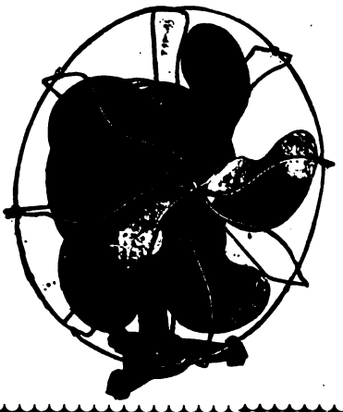
An Extra EDISON Armature, 45 K. W., 500 volts, NEW, - - - - $150.00

A 30 K. W. United States Dynamo, 110 volts. Fine condition, great bargain, - $310.00

A 20 K. W. Western Electric Dynamo, 125 volts, medium speed, self-oiling, self-aligning bearings. NEW, - $300.00

A lot of JANDUS ARC LAMPS, 150-hour, 110 volts, Warranted, - - - $11.00 to $13.00

A lot of T-H. K2 and K12 Arc Lamps, thoroughly overhauled, fully warranted, $7.00



# ENGINEERING CO.

## OHIO.


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A

in your
ing to the
machines.
and if your
finest expert
anywhere.

**We solicit, particularly,** repair work of **large armatures and lighting machines,** because of our facilities for handling such a large class of work. We do not, however, neglect **small orders,** and you are assured that the smallest order will receive prompt attention and be handled with dispatch.

**OUR LINES include Armatures, Commutators, Transformers, Platers, Arc Lamps, Experimental Work and Second-hand Dynamos and Motors.**

# W. H. ELLIOTT

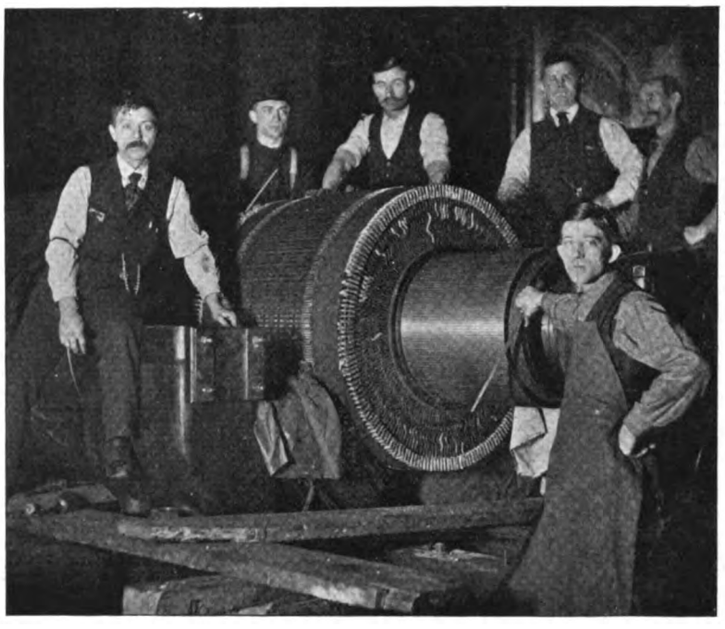
CLEVELAND,

DAY 'PHONE, MAIN 2571.


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# CAKE WALK

**Dynamos** and **Motors** would undoubtedly be highly edify- **"Niggers"** there-in, but it wouldn't **"do a thing"** to your Please bear in mind that we are professional **"Nigger Chasers,"** apparatus is sent to us for repairs, you are guaranteed, absolutely, the workmanship and the advantages of the best facilities obtainable



500 K. W. G. E. RY. GENERATOR,
Wound by us for the Cleveland Elec. Ry. Co.

# ELECTRIC COMPANY,

## OHIO.

NIGHT 'PHONE, DOAN 405-J.


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# Automatic Set Back Annunciators

PATENTED.




4 Number.

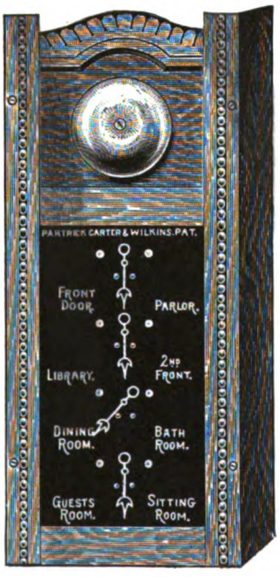
Made in the following sizes:

4, 6, 8, 10,
12, 16, 20, Nos.



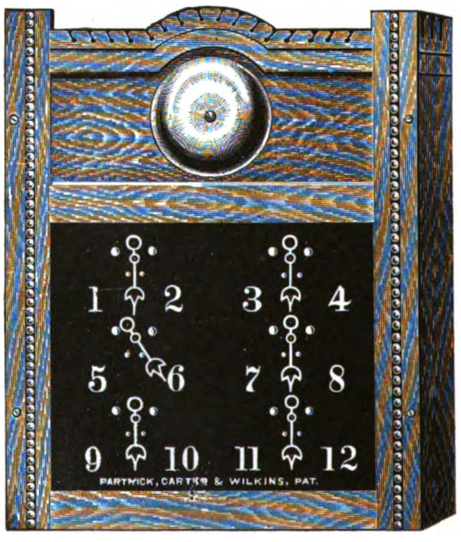

8 Number, "Plush" Case.

## The Best House Annunciator on the Market.




8 Number.

*Descriptive Catalogue and Prices on Application.*




12 Number.

# PARTRICK, CARTER & WILKINS,

Manufacturers of **Electrical House Goods,**

125 South Second Street, **PHILADELPHIA, PA.**

ESTABLISHED 1867.


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# Safety

In addition to supplying "SAFETY" Seamless Rubber-Covered Wire and Cable in increasing quantities to our regular patrons in the Telegraph, Telephone, Electric Light and Transmission Power Industries, we have recently made for the

## U. S. Government

(Submarine Cable for Cuba and Manila)

680 Miles of Submarine Cable for National Defense
(The only deep sea cable made in America)

And are now making for the

## Metropolitan Street R. R.

of New York
(Lead-Covered Underground Feeder Cable)

Over $500,000 worth of Rubber-Covered and Lead-Incased Feeder Cable.

"Safety" Insulated Wire and Cable for aerial, and "Safety" Rubber-Covered and Lead-Incased Cable for underground purposes, have the endorsement of some of the largest users of insulated wire and cable

## The Safety Insulated Wire and Cable Company

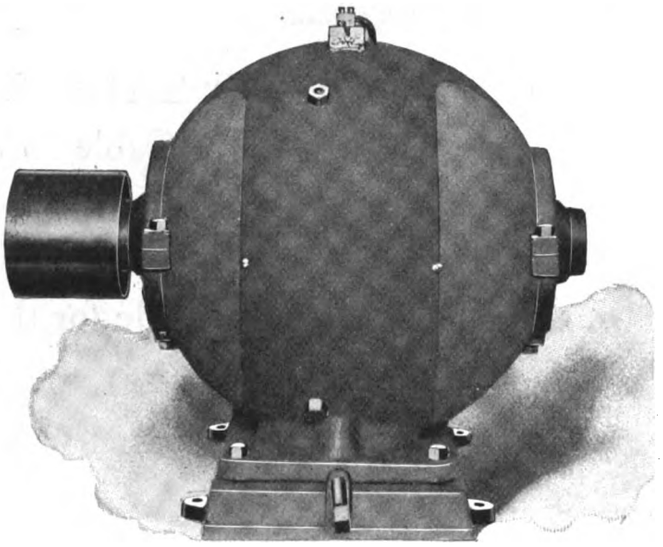
LEONARD F. REQUA
General Manager

223-239 West 28th Street, New York City


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# ROTH'S Multipolar Dynamos and Motors

Open and Enclosed Type.



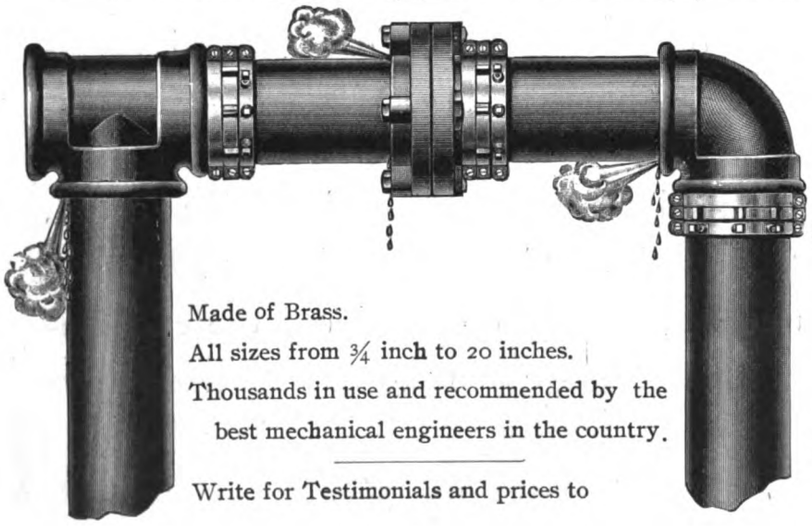
Slow and Moderate Speeds.

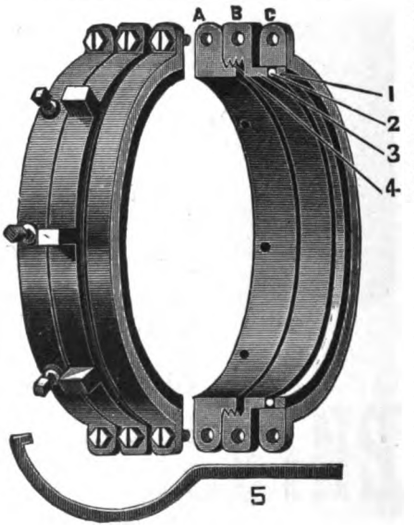
## ROTH BROS. & CO.,

88-92 West Jackson Street, CHICAGO, ILL.

# THE CLIMAX STEAM JOINT CLAMP

Stops the Leak on any joint where the pipe is screwed into the fitting






Made of Brass.
All sizes from ¾ inch to 20 inches.
Thousands in use and recommended by the best mechanical engineers in the country.

Write for Testimonials and prices to

**JAMES McCREA & CO.**, Manufacturers, 11 & 13 S. Canal St., Chicago.

BARRETT & PLOWMAN, Eastern Agents,
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C. K. NICHOLS & CO., 40 Water St., Boston, Mass.
JOSEPH H. MEYER, Agent, 113 E. 3d St., Cincinnati, Ohio.
McCARDLE & CO., 514 Camp St., New Orleans, La.

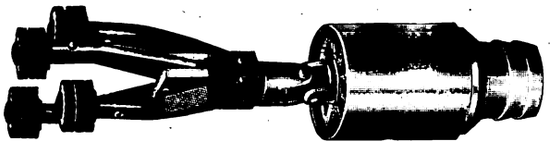
1 Represents a ring of packing.
2 Represents follower ring.
3 Represents blank face in "B."
4 Represents male and female threads in "A" and "B."
5 Represents spanner.

**The clamps are made in halves, held together by cap screws, therefore can be easily attached to pipe.**


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# Scale Formation In Water Tube Boilers

Is a **SPLENDID NON-CONDUCTOR.** It reduces their capacity, efficiency and economy, increases fuel and repair bills and shortens the life of the boiler.



## OUR TURBINE CLEANER

Restores their capacity and efficiency, reduces fuel bill 20 to 50 per cent., practically eliminates repairs, and saves its cost every 30 days. Hundreds in constant use by the **BEST FIRMS IN AMERICA.** Sent anywhere on approval.

We have the simplest and best **POWER DRIVEN CLEANERS,** which we lease or sell at One-Fourth usual prices.

We clean boilers by contract, or do it by the day, if preferred, for less money than any other firm.

Our **PHOENIX COMBINED SCRAPER AND BLOWER** for **TUBULAR BOILERS** is the only Flue Cleaner which Cleans a Flue **CLEANER THAN WHEN NEW**

Outlasts 50 cast iron scrapers. Indestructible, Self-Adjusting, **PERFECT.** Sent on approval.

Send us a sample of water or scale. We will analyze it **FREE OF CHARGE** and furnish a Compound which we **GUARANTEE** to Loosen the Scale and Prevent its re-formation.

We cover the Entire Field of **BOILER CLEANING.** We make it our sole business to Annihilate Scale.

If you will write us full particulars we will outline the most Economical Plan for Cleaning Your Boilers.

**AGENTS WANTED.**

# CHICAGO BOILER CLEANER CO.

258 Dearborn Street, Chicago, Ill.


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# SOME COMMENTS On NEW YORK TELEPHONE SERVICE.

**A PHYSICIAN SAID:—"I would as soon think of taking off the door bell as of doing without the telephone service."**

**A BUSINESS MAN SAID:—"For economy's sake I had done without the telephone service until lately. I had it put in less than a year ago. Now I would not give it up for FIVE HUNDRED DOLLARS A YEAR."—(He pays 75.)**

**THE HEAD OF A LARGE FIRM SAID:—"The telephone service is the cheapest thing we have in our office."**

Whether used on a large scale or on a small scale, the telephone service, weighed by its performance, is the cheapest thing in modern life.

MESSAGE RATES make cost of telephone service in New York very moderate.

STANDARD EQUIPMENT for all subscribers. The rate varies with the amount of use.

## NEW YORK TELEPHONE COMPANY,

**15 Dey Street, 952 Broadway, 115 West 38th Street.**

# National Electric Light Association

## NEW YORK CITY, MAY 23-25, 1899.

RATE.—A fare and one-third for the round trip, making the fare from Chicago via the Wabash and West Shore $24.00 for the round trip.

Arrangements have been made with The Wabash Railroad for a Special Train from Chicago to New York, to leave Dearborn Station, corner of Dearborn and Polk Sts., at 12:02 Noon, Sunday, May 21, and arrive in New York at 3:30 P. M. next day. This train will run via the Wabash to Niagara Falls and thence West Shore, giving passengers a day-light ride of several hours down the west bank of the Hudson River.

TICKET OFFICE, 97 ADAMS STREET, CHICAGO.

**F. A. PALMER, A. G. P. Agent, Chicago.** **N. C. KEERAN, C. P. & T. A. Agent.**


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# DO YOU THINK?

YOU CAN FIND ANY DEFECTS IN OUR INSTRUMENTS, AFTER OUR TRAINED EXPERT INSPECTORS HAVE "O.K'D" THEM? WE THINK NOT.

READ OUR GUARANTEE AND THEN LOOK UP OUR COMMERCIAL STANDING, IN "BRADSTREETS" OR DUN'S. THIS WILL CONVINCE YOU THAT OUR GUARANTEE IS WORTH SOMETHING. IT MIGHT INTEREST YOU TO LOOK UP SOME OF OUR ESTEEMED COMPETITORS, ALSO.




## SWEETS...

# DIRECT SEPARATORS

**For Removing Water from Live Steam, and Oil from Exhaust Steam.**

**Evidence of Satisfaction they Give**

| | | | | | |
|---|---|---|---|---|---|
| 1 User | | 46 Orders | | 82 Separators | |
| 1 " | | 9 | " | 34 | " |
| 1 " | | 17 | " | 22 | " |
| 1 " | | 6 | " | 13 | " |
| 1 " | | 5 | " | 5 | " |
| 4 " | ea. | 4 | " | 25 | " |
| 14 " | " | 3 | " | 67 | " |
| 40 " | " | 2 | " | 109 | " |

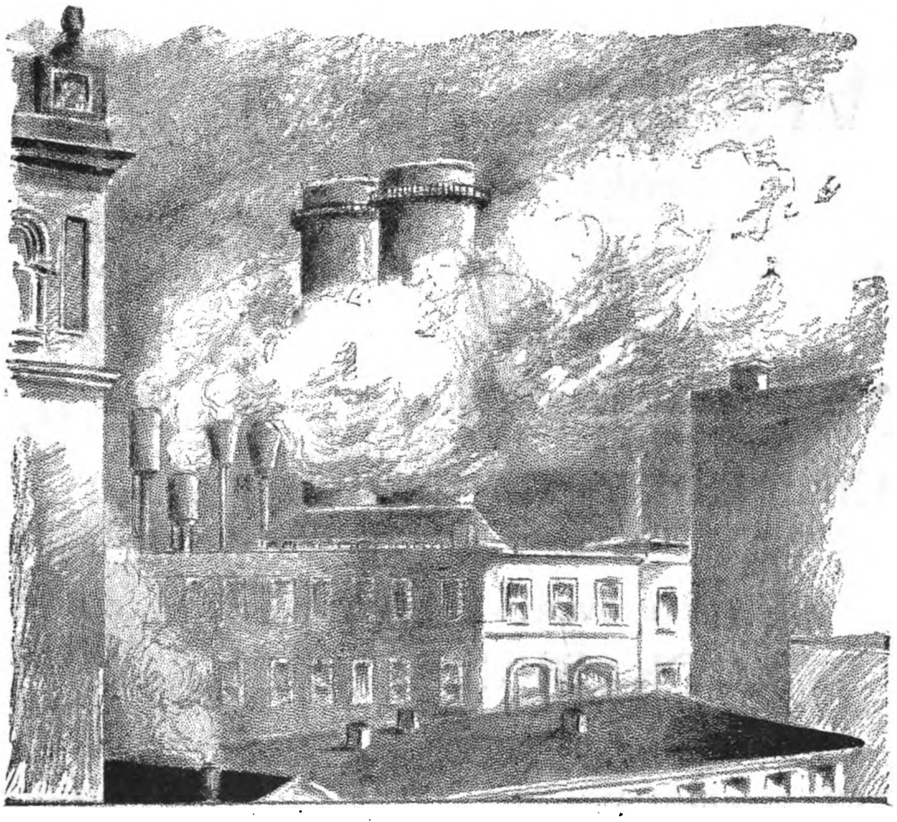
Users, not dealers.

**DIRECT SEPARATOR CO.,**

**240 So. Geppes St.,**

**SYRACUSE, N. Y.**

Made All Styles and Sizes.



# "RICHES TAKING UNTO THEMSELVES WINGS."

Here is a realization from actual life of this old adage, quoted above. It is a view you can see any day of a well-known power plant in one of our large cities. And the amazing spectacle is duplicated in every large city in the country. This waste steam represents thousands of dollars which would go towards augmenting profits and paying dividends. If you would like to know how, send for our pamphlet.

# AMERICAN DISTRICT STEAM CO., LOCKPORT, N. Y.


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# ERIE RAILROAD.

PICTURESQUE

TRUNK LINE OF AMERICA.




## SOLID VESTIBULED TRAINS

CONSISTING OF

SLEEPING, DINING AND CAFÉ CARS

BETWEEN

NEW YORK AND BUFFALO, CLEVELAND, CINCINNATI AND CHICAGO.

PROTECTED EVERYWHERE BY

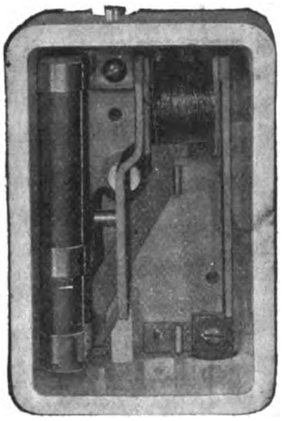
... BLOCK SIGNALS ...

D. I. ROBERTS, General Passenger Agent, NEW YORK.


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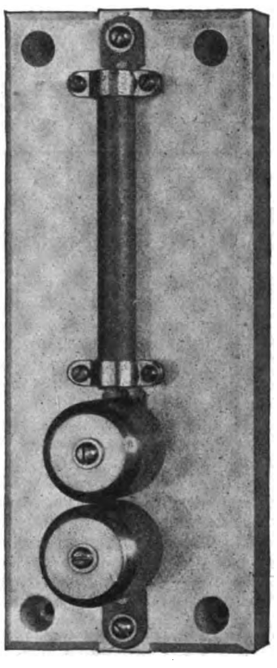
THE

# GENERAL ELECTRIC COMPANY'S Lightning Arresters



are the cheapest form of insurance ever devised.

The General Electric M D Lightning Arresters, embodying the magnetic blow-out principle, are used by all the large companies in the world which make direct current for railway, lighting or power purposes.



The Short Gap Alternating Current Lightning Arresters, for all potentials, made by the General Electric Company, gives ample protection to the circuit, because they are the point of least resistance, though always effective in limiting the generating current.

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Philadelphia, Pa., 509 Arch St.
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Pittsburg, Pa., 502 Tradesmen's Bank Bldg.
Atlanta, Ga., Equitable Bldg.
New Orleans, La., 917 Hennen Bldg.
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Columbus O., 14 N. High St.

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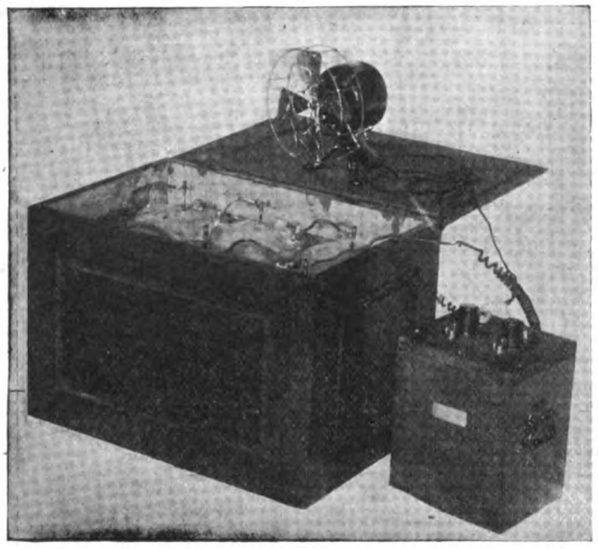
SCHENECTADY, N. Y.

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For Canada, address Canadian General Electric Company, Ltd., Toronto, Ontario.

Nashville, Tenn., 306 N. Summer St.
Chicago, Ill., Monadnock Bldg.
Detroit, Mich., 704 Chamber of Commerce Bldg.
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Dallas, Texas, Scollard Bldg.
Helena, Mont., Electric Bldg.
Minneapolis, Minn., Phoenix Bldg.
Denver, Col., Kittredge Bldg.
Salt Lake City, Utah, Templeton Bldg.
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Portland, Ore., Worcester Bldg.

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# "EXCELLO"
# Fan Motor and Battery Outfits.

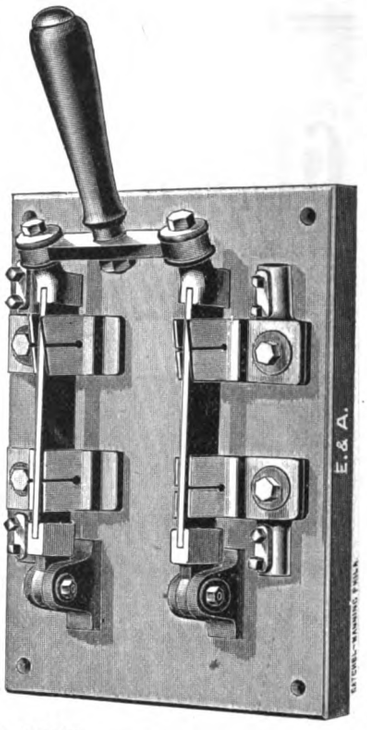
Clean, Noiseless, Iron Clad, Highly Efficient; 8-in. fan and guard: requires no attention. Renewals, consisting of simple bluestone and zinc, required only once in six months. Runs on 4 volts and consumes only 1½ amperes of current. Self-oiling bearing. Suitable for any service where the commercial current is not available. Send for illustrated circular to

**BURNHAM ELECTRIC CO.,**
145 FRANKLIN STREET, BOSTON.

The oldest established Switch business in the U. S.

Manufacturers of the BEST

# Switches
and...
# Switch Boards.




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15 N. 7th Street, PHILADELPHIA, PA.

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# Mechanical Catechism



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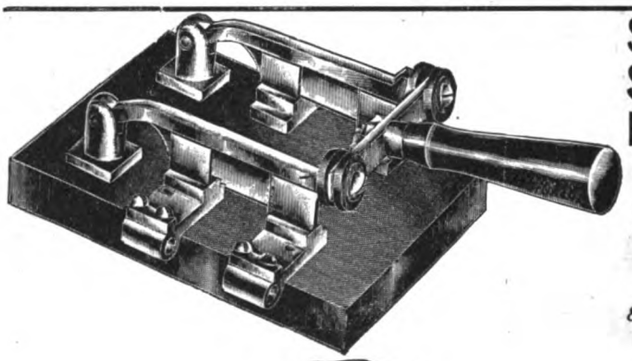
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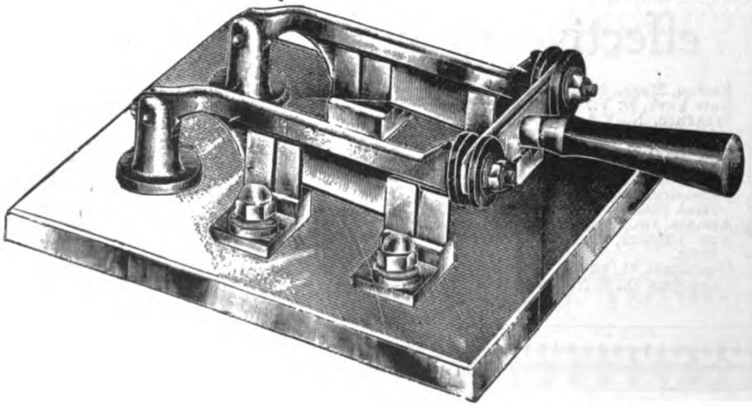
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AMERICAN ELECTRICIAN CO.,
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## Switches, Switch Boards, Panel Boards.

Send us your specifications. We promise you a low price.

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THE BRYANT ELECTRIC CO.

MANUFACTURERS OF ELECTRIC LIGHT SUPPLIES.

EASTERN OFFICE AND FACTORY.
BRIDGEPORT, CONN.

WESTERN OFFICE & STORE ROOMS
THE MONADNOCK, CHICAGO.
E. R. GRIER, MANAGER.

BRYANT D. P. SWITCHES.
STANDARD LAMP BASES
K. W. ROSETTES.

BRIDGEPORT, CONN. May 10th, 1899

-8694-

Amherst Electric Light Co.,

Amherst, Penn.

Gentlemen:-



No. 9402.



No. 9333.



No. 9364.



No. 9358.

We are now prepared to furnish standard Edison base material in all modifications, including fibre lined key and keyless sockets for 220 volt work and all receptacles and weatherproof sockets which we have been furnishing in the past in T. H. and Westinghouse base. If your system is installed with Edison base material we are confident that this matter will interest you and will be glad on request to mail you our special catalogue devoted to this part of our line.

The sale of supplies manufactured by us is handled entirely through our authorized agents and the larger supply houses.

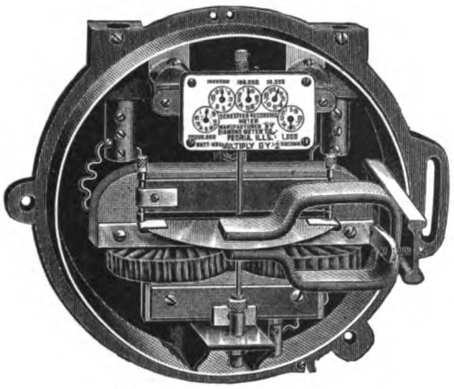
Every responsible jobber in the United States and Canada is in position to quote upon and ship our goods from stock. If you are unable to obtain our goods promptly from your jobber, kindly write us direct and we will arrange or the proper handling of your orders.

Yours truly,

THE BRYANT ELECTRIC CO.

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# SCHEE



METER WITHOUT CASE.

## Meter, Type D.

Accurate
on all loads.




METER WITH CASE.

Shunt loss LESS than one Watt on 60 Cycles.

Dust Proof.

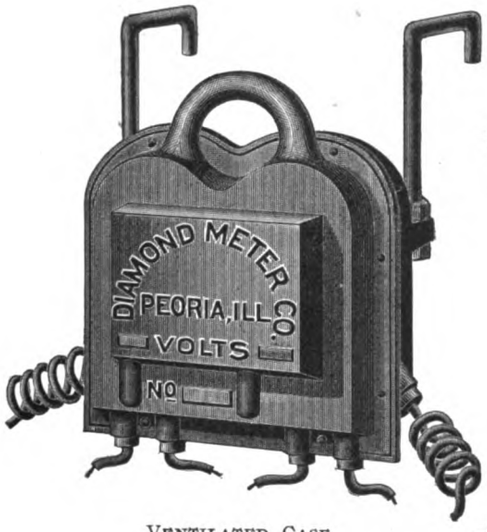
Correct on all inductive loads.

Will start and register correctly on 5 Watts

# DIAMOND METER


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# F F E R



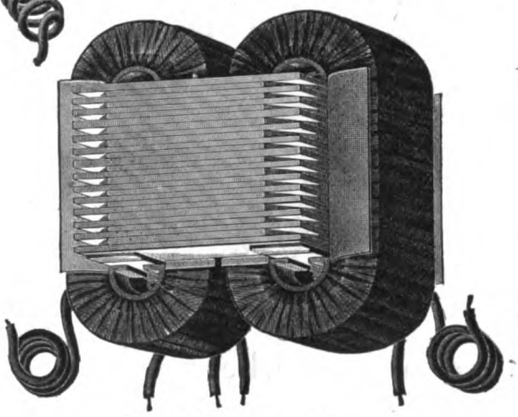

VENTILATED CASE.

## Transformer, Type L.

Improved Core Type.

Double the Ventilating Surface without increasing the size of transformer.

Iron loss guaranteed at the smallest percentage.



PATENT APPLIED FOR.

New Method of Ventilation.

Furnished in Ventilated and Oil Cases.
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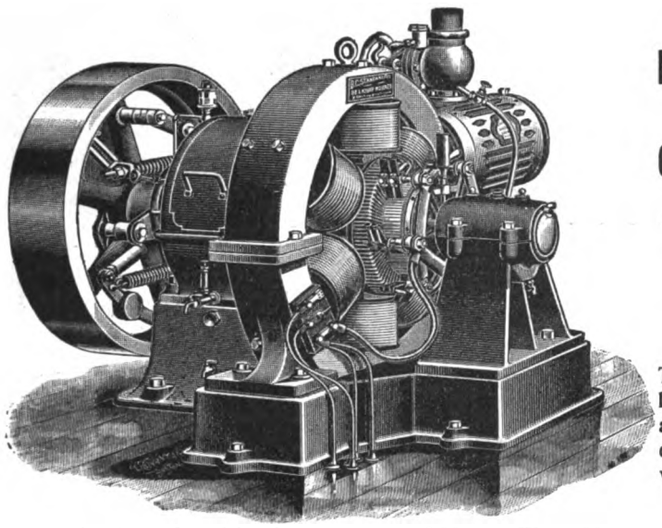
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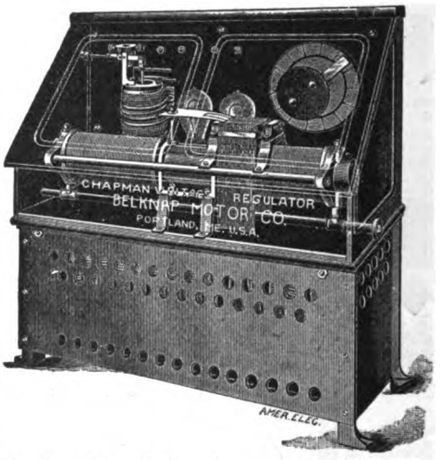

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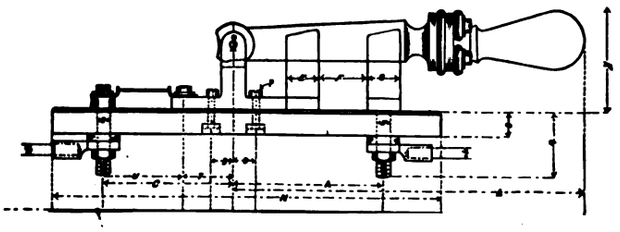
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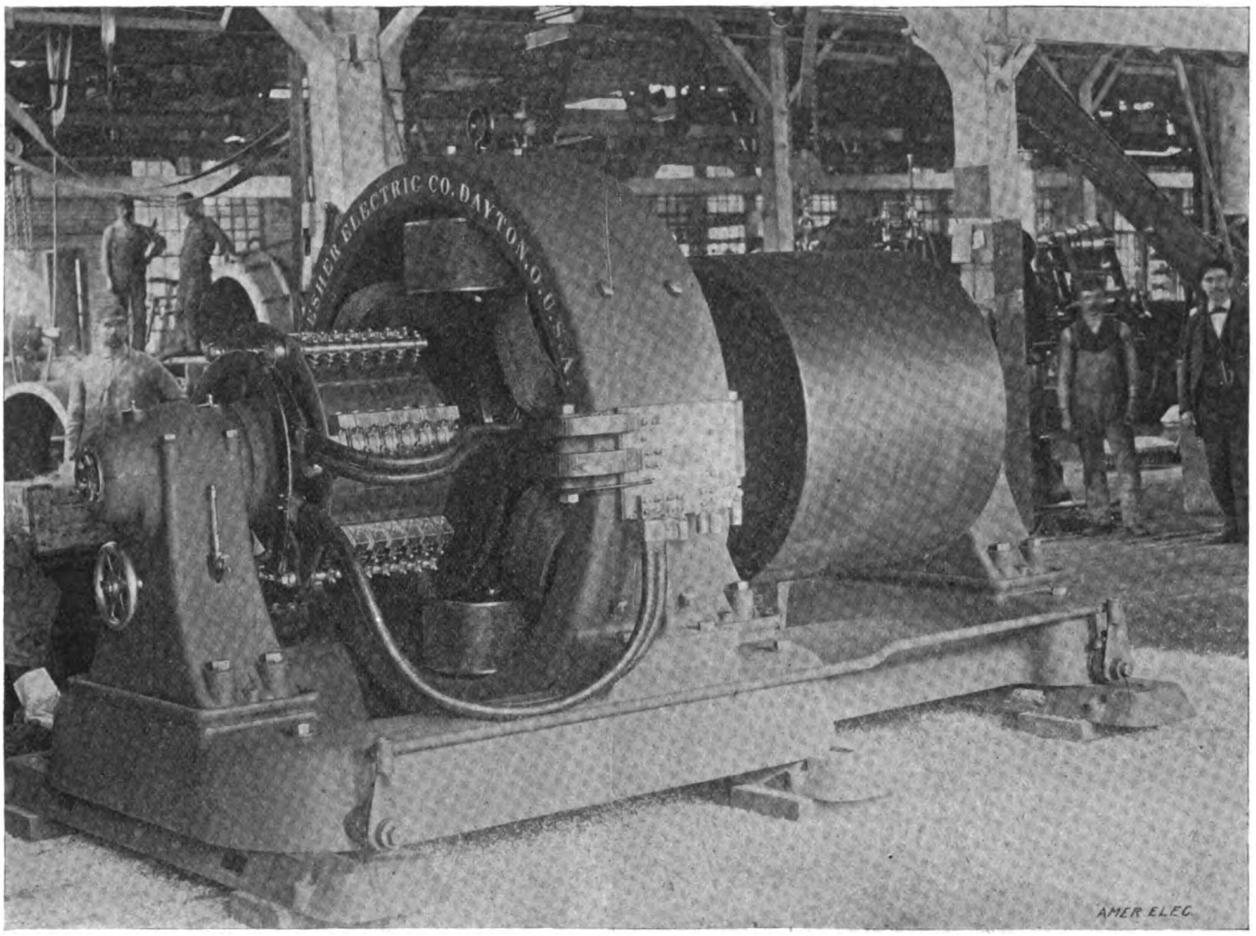
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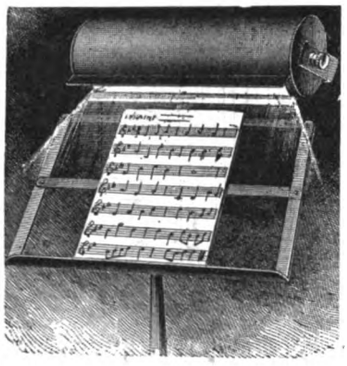
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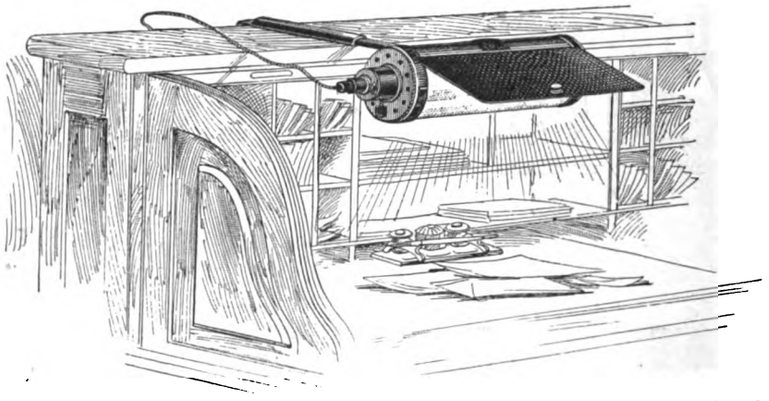
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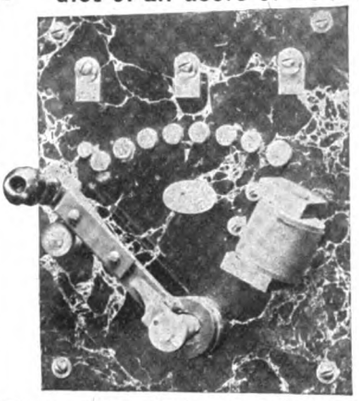
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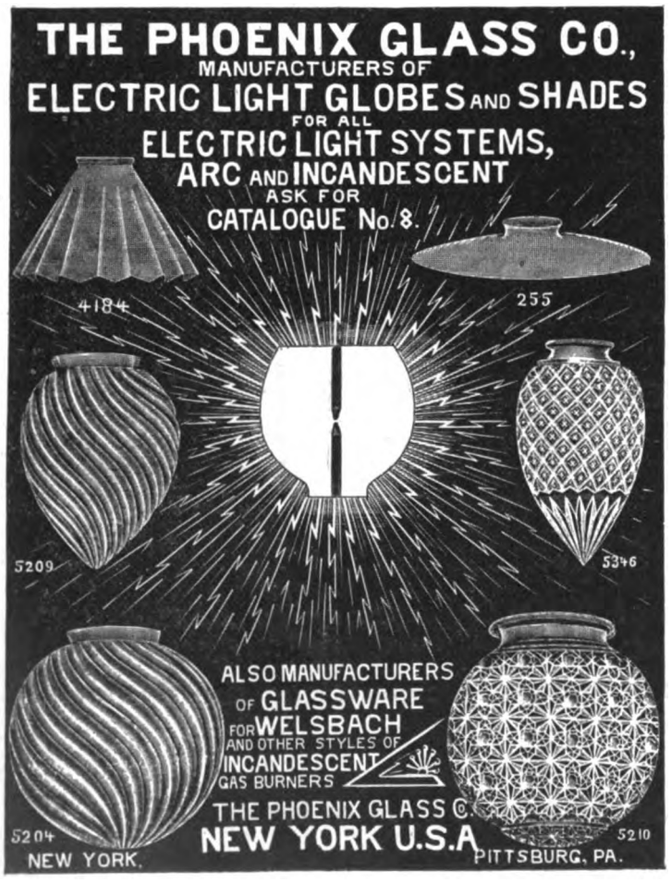


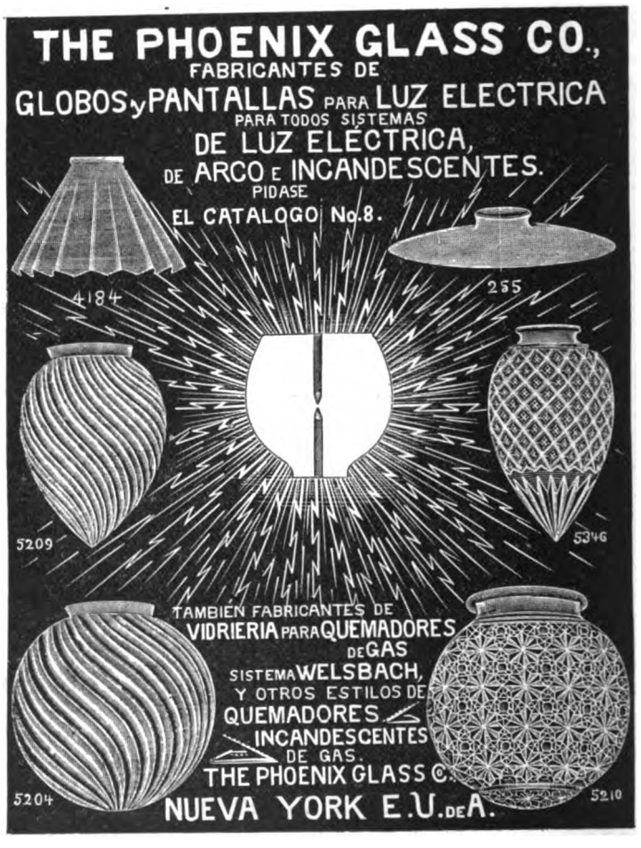
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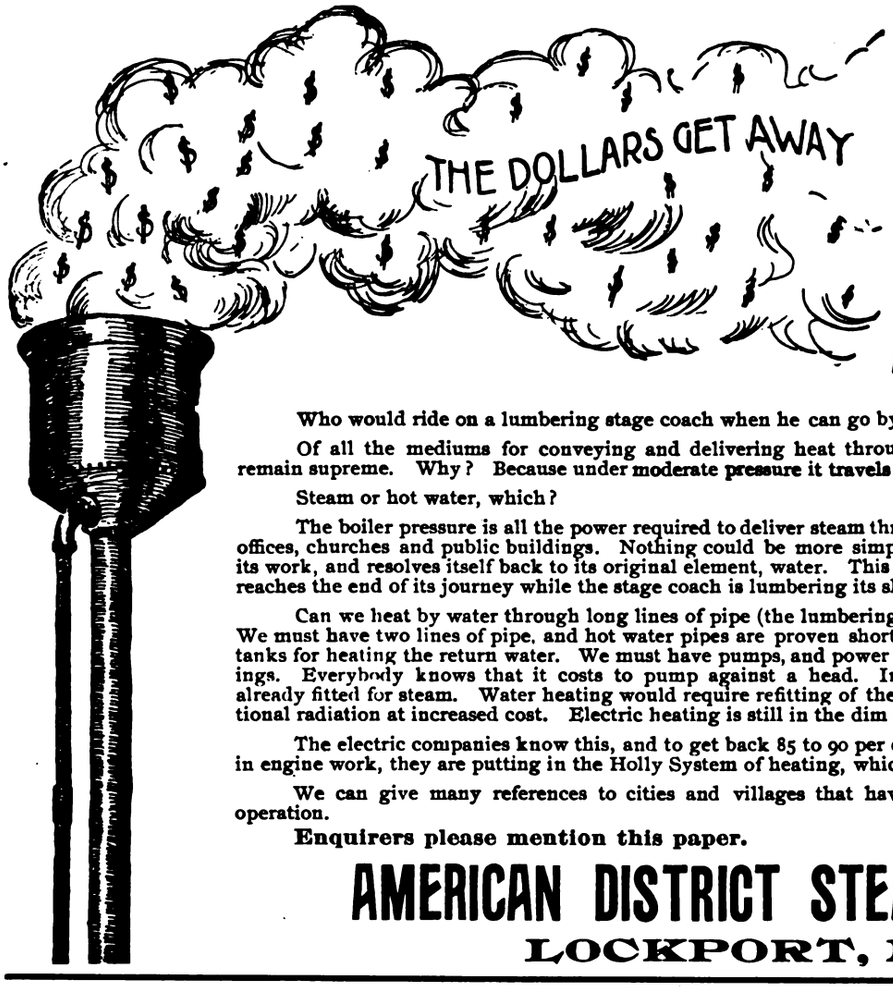
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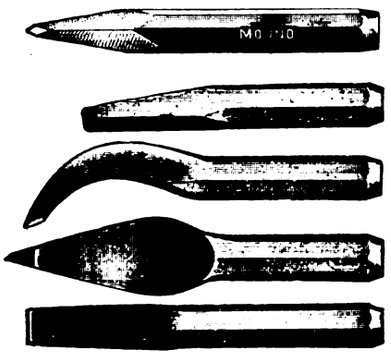



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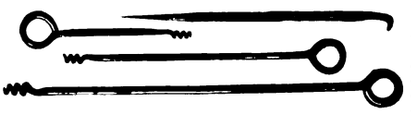
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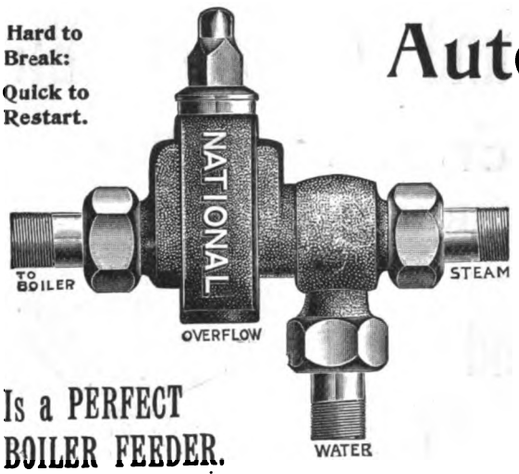
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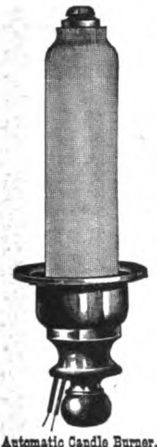
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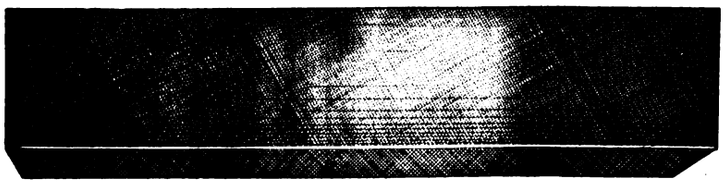
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| | 7 | .48 | .51 | .54 | .55 | .63 | .74 | .86 | .88 | .92 | .96 | 1.00 | 1.04 | 1.12 | 1.24 | 1.28 | 1.32 | 1.40 |
| | 8 | .55 | .56 | .60 | .64 | .74 | .85 | .98 | 1.00 | 1.04 | 1.12 | 1.16 | 1.20 | 1.32 | 1.40 | 1.44 | 1.52 | 1.60 |
| 5-16 | 7 | .50 | .52 | .64 | .79 | .92 | .88 | 1.06 | 1.08 | 1.16 | 1.20 | 1.24 | 1.32 | 1 44 | 1.52 | 1.60 | 1.64 | 1.76 |
| | 8 | .56 | .60 | .75 | .90 | 1.05 | 1.06 | 1.20 | 1.24 | 1.32 | 1.36 | 1.44 | 1.52 | 1.64 | 1.76 | 1.80 | 1.88 | 2.00 |
| | 10 | .70 | .75 | .95 | 1.12 | 1.31 | 1.32 | 1.41 | 1.56 | 1.64 | 1.72 | 1.80 | 1.88 | 2.03 | 2.19 | 2.26 | 2.34 | 2.50 |
| 3/8 | 7 | .60 | .63 | .72 | .95 | 1.10 | 1.26 | 1.30 | 1 32 | 1.36 | 1.44 | 1.52 | 1.56 | 1.72 | 1.84 | 1.92 | 1.96 | 2.12 |
| | 8 | .70 | .72 | .84 | 1.08 | 1.26 | 1.44 | 1.48 | 1.52 | 1.56 | 1.64 | 1.72 | 1.80 | 1.96 | 2.12 | 2.16 | 2.24 | 2.40 |
| | 10 | .84 | .90 | 1.08 | 1.23 | 1.44 | 1.65 | 1.70 | 1.88 | 1.97 | 2.06 | 2.16 | 2.25 | 2.45 | 2.63 | 2.72 | 2.81 | 3.00 |
| 7-16 | 7 | .69 | .74 | .92 | 1 00 | 1.28 | 1.35 | 1 38 | 1.52 | 1.60 | 1.68 | 1.76 | 1.84 | 1.96 | 2.12 | 2.24 | 2.28 | 2.44 |
| | 8 | .79 | .84 | .96 | 1.16 | 1.35 | 1.54 | 1.58 | 1.76 | 1.84 | 1.92 | 2.00 | 2.12 | 2.28 | 2.44 | 2.56 | 2.64 | 2.80 |
| | 10 | .98 | 1.05 | 1.20 | 1.44 | 1.68 | 1.92 | 1.95 | 2.20 | 2.29 | 2.40 | 2.52 | 2.63 | 2.84 | 3 06 | 3.17 | 3.28 | 3.50 |
| 1/2 | 7 | .70 | .84 | .96 | 1.16 | 1.35 | 1.54 | 1.58 | 1.76 | 1.84 | 1.92 | 2 00 | 2.12 | 2.28 | 2.45 | 2.54 | 2.63 | 2.80 |
| | 8 | .90 | .96 | 1.10 | 1.32 | 1.54 | 1.76 | 1.80 | 2.00 | 2.12 | 2.20 | 2.32 | 2.40 | 2.60 | 2.80 | 2.90 | 3.00 | 3.20 |
| | 10 | 1.13 | 1.20 | 1.38 | 1.65 | 1.92 | 2.20 | 2.25 | 2.50 | 2.63 | 2.75 | 2.88 | 3.00 | 3.25 | 3.50 | 3.63 | 3.75 | 4.00 |
| 5/8 | 7 | .98 | 1.05 | 1.20 | 1.44 | 1.68 | 1.75 | 1.94 | 2.19 | 2.30 | 2.40 | 2.52 | 2.63 | 2.85 | 3.06 | 3.18 | 3.28 | 3.50 |
| | 8 | 1.12 | 1.20 | 1.38 | 1.65 | 1.92 | 2.00 | 2.25 | 2 50 | 2 62 | 2 75 | 2.88 | 3.00 | 3.25 | 3.50 | 3 64 | 3 75 | 4.00 |
| | 10 | 1.40 | 1 50 | 1.72 | 2.06 | 2.40 | 2.50 | 2.82 | 3 13 | 3.28 | 3.44 | 3 60 | 3 75 | 4.06 | 4.34 | 4.54 | 4.70 | 5.00 |

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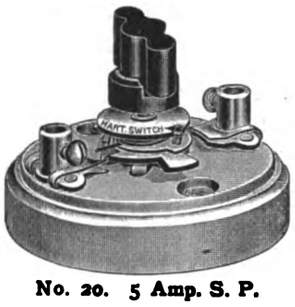



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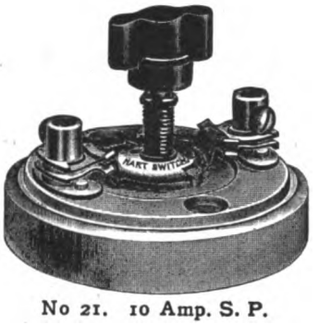
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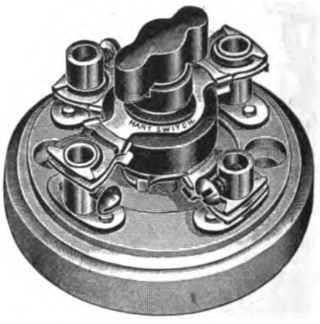
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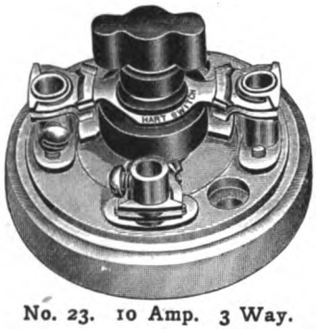

No. 20. 5 Amp. S. P.



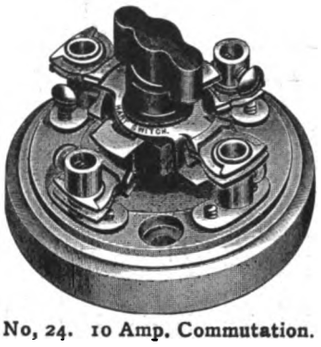

No 21. 10 Amp. S. P.



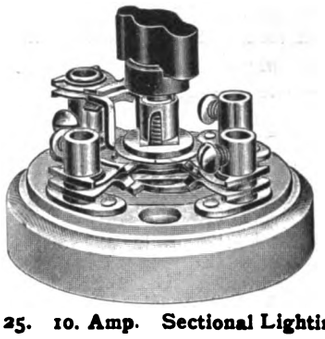
Nos. 22, 32 and 42.
10 Amp. D. P. 20 Amp. D. P.
35 Amp. D. P.



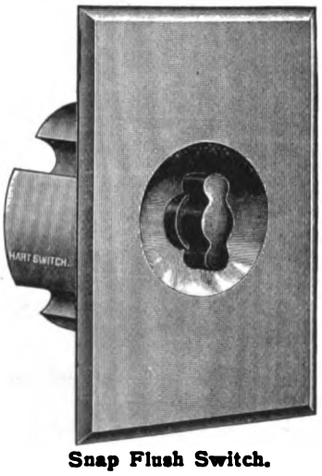
No. 23. 10 Amp. 3 Way.



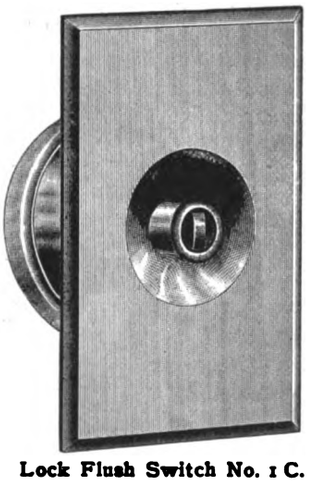
No, 24. 10 Amp. Commutation.



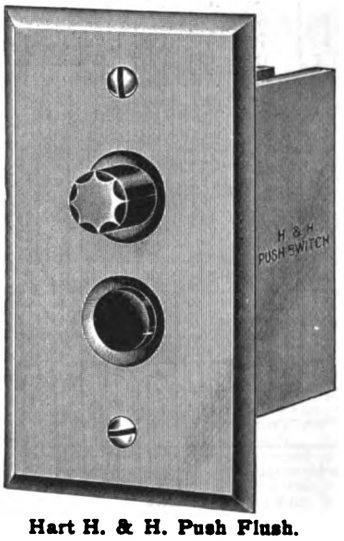
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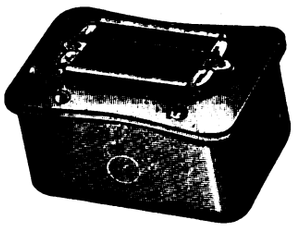
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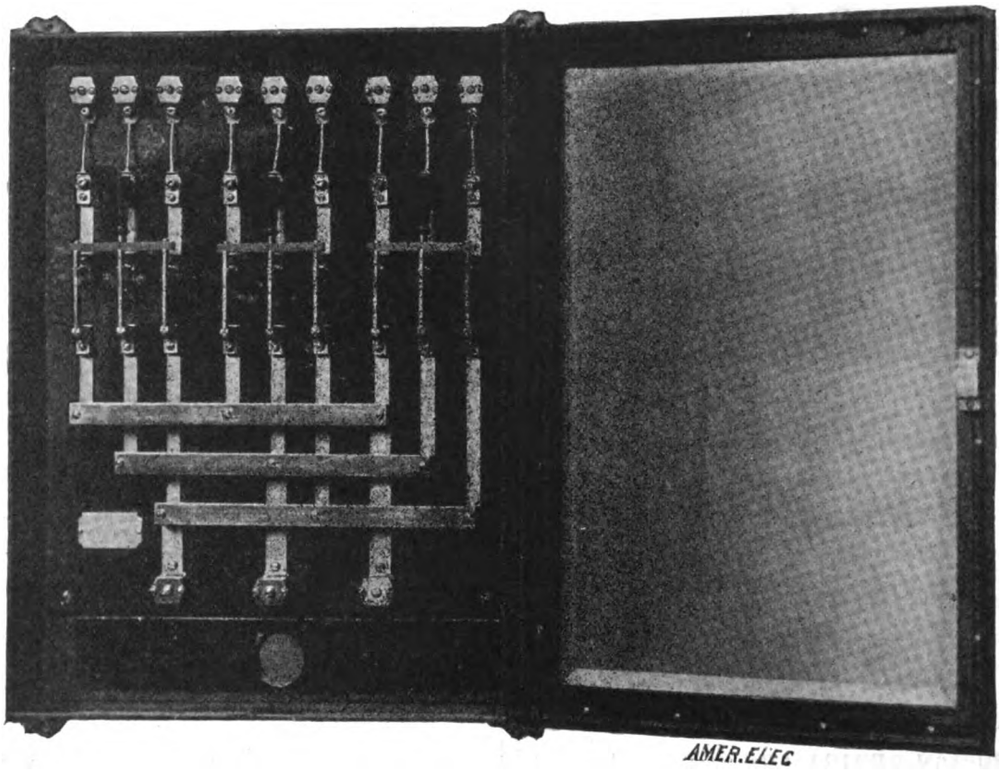
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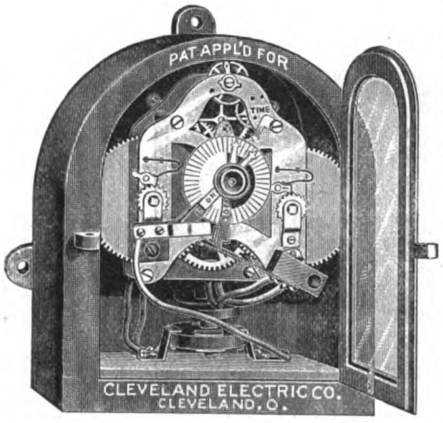
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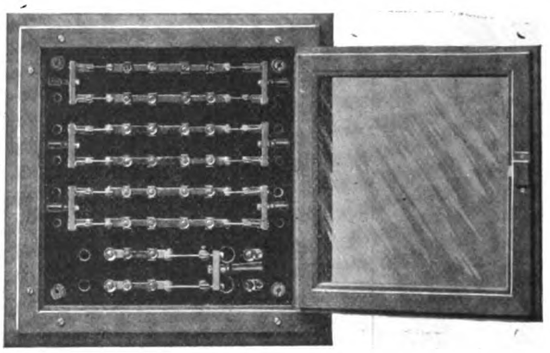
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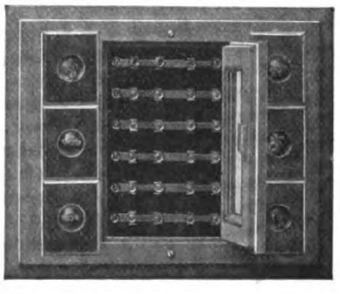


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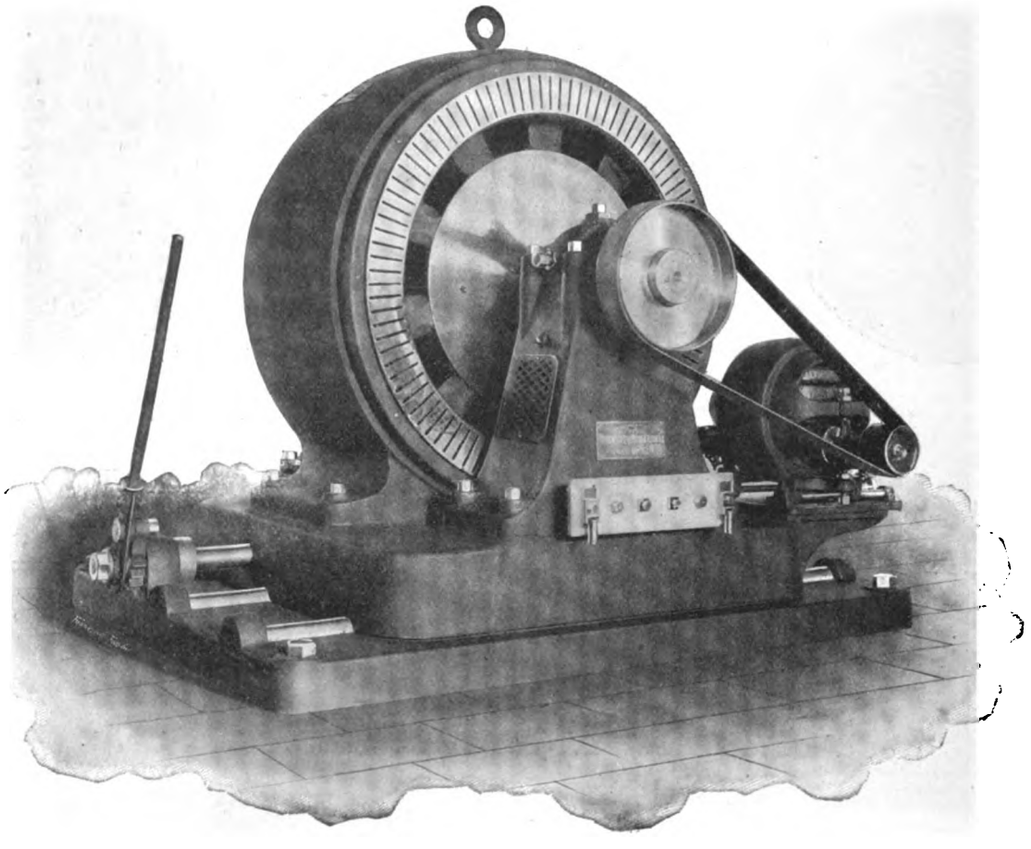

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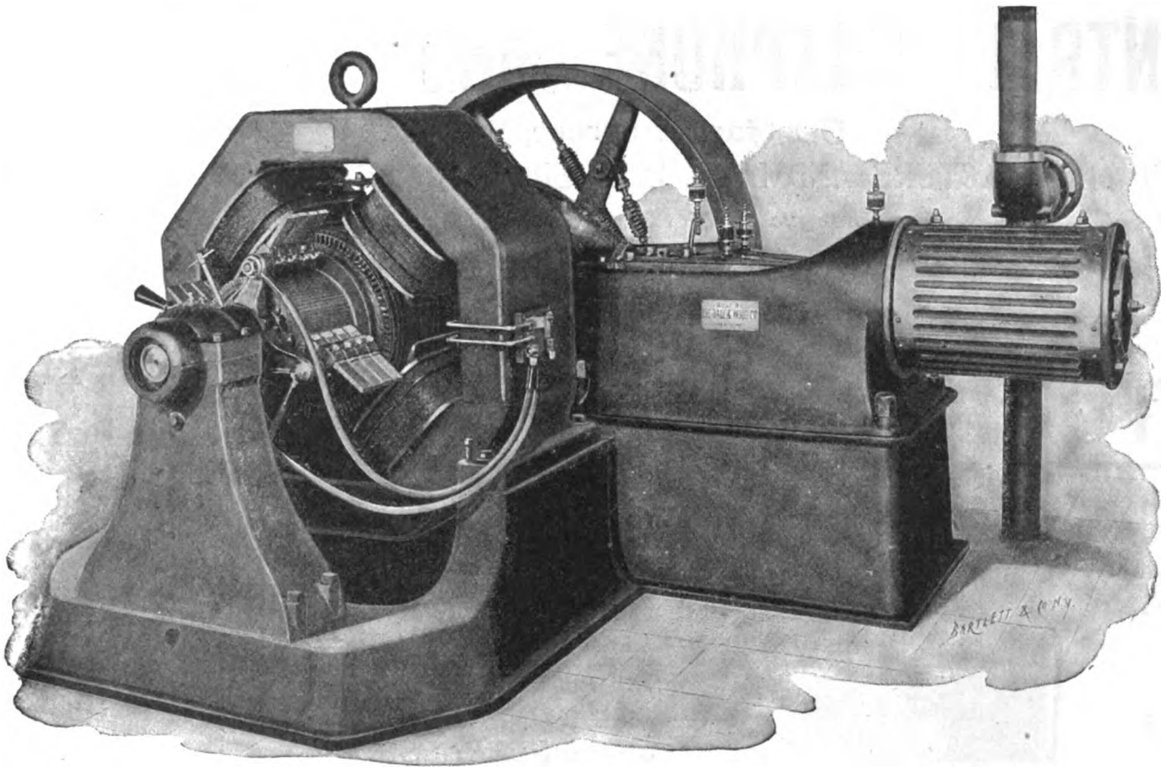
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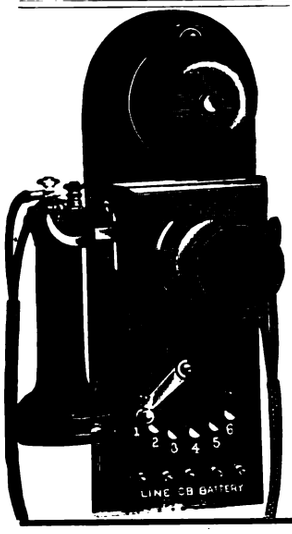
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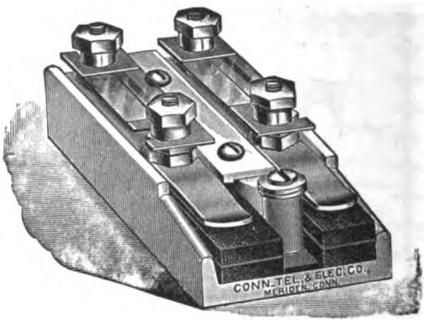
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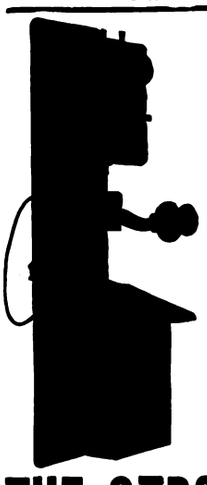
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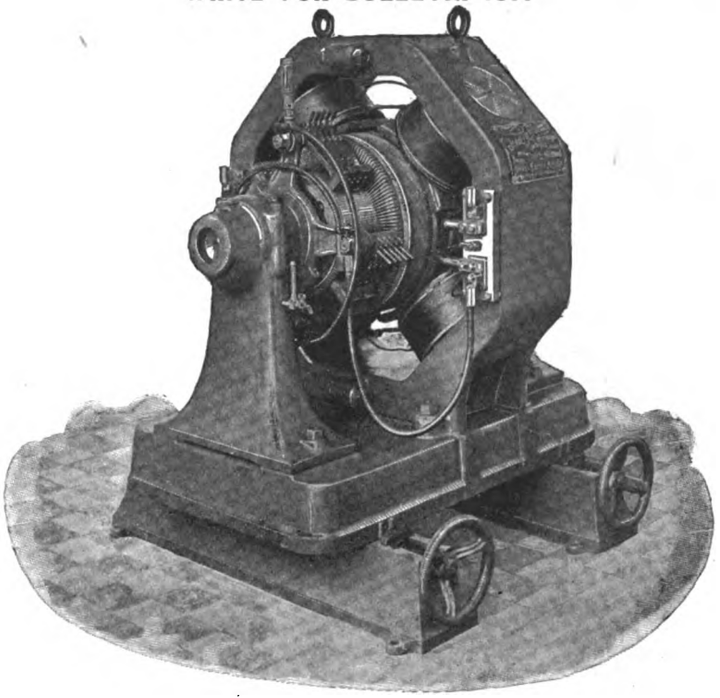
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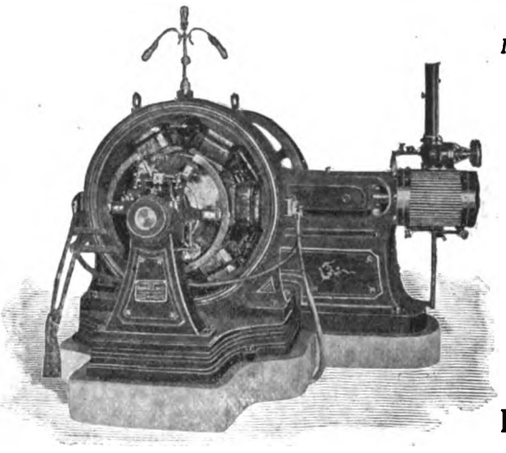
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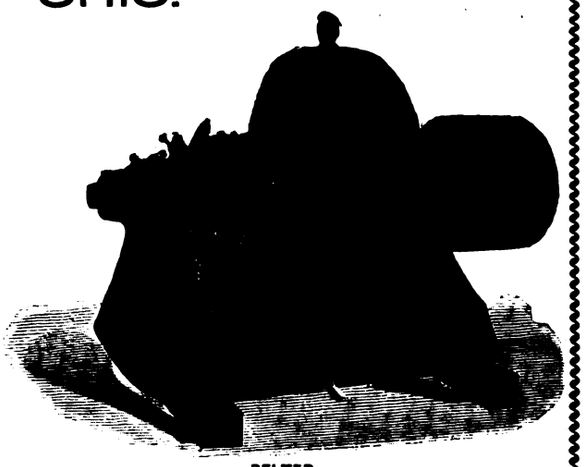
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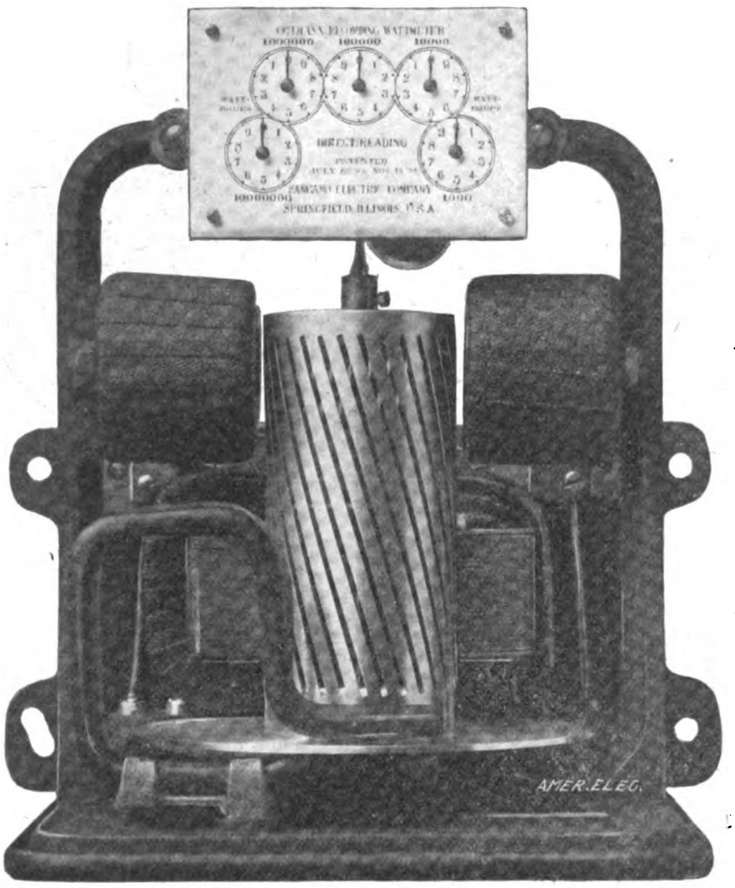
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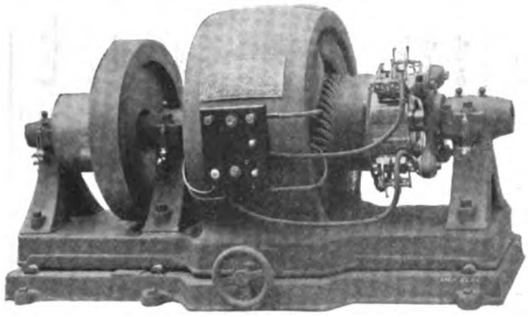
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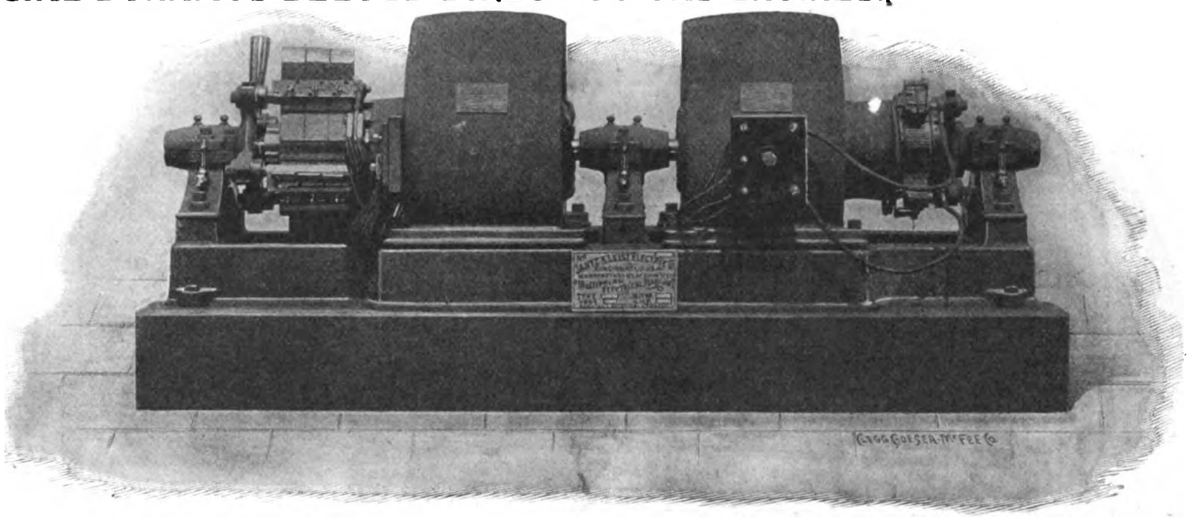
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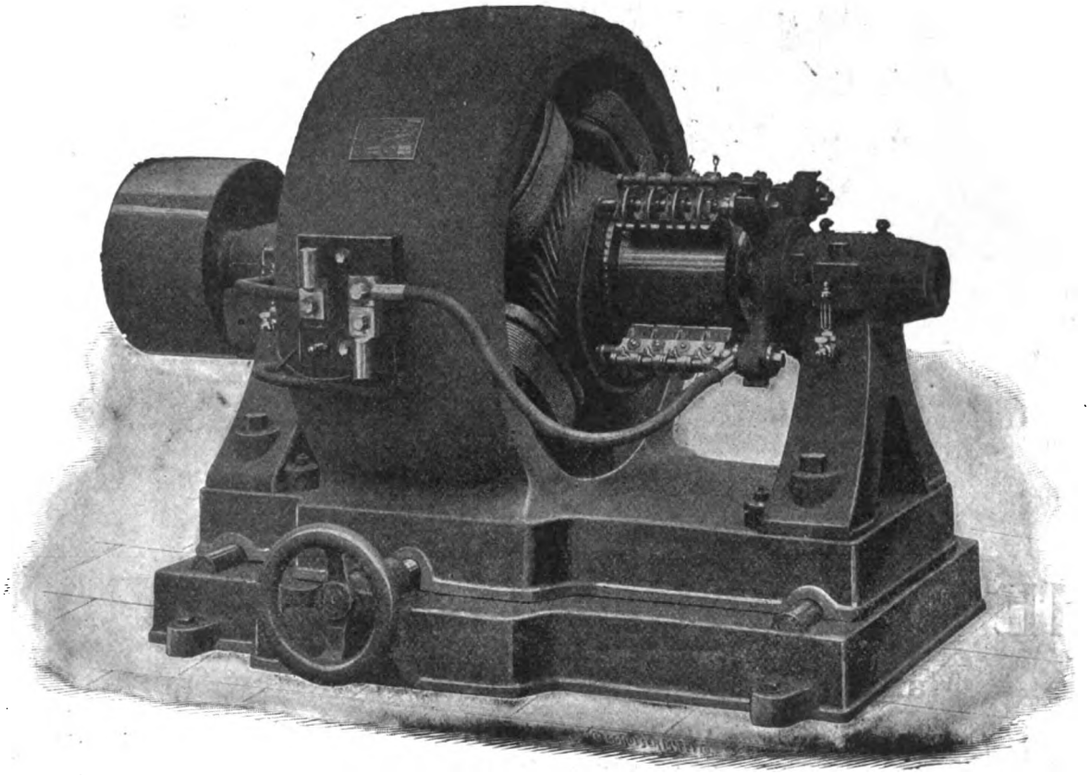


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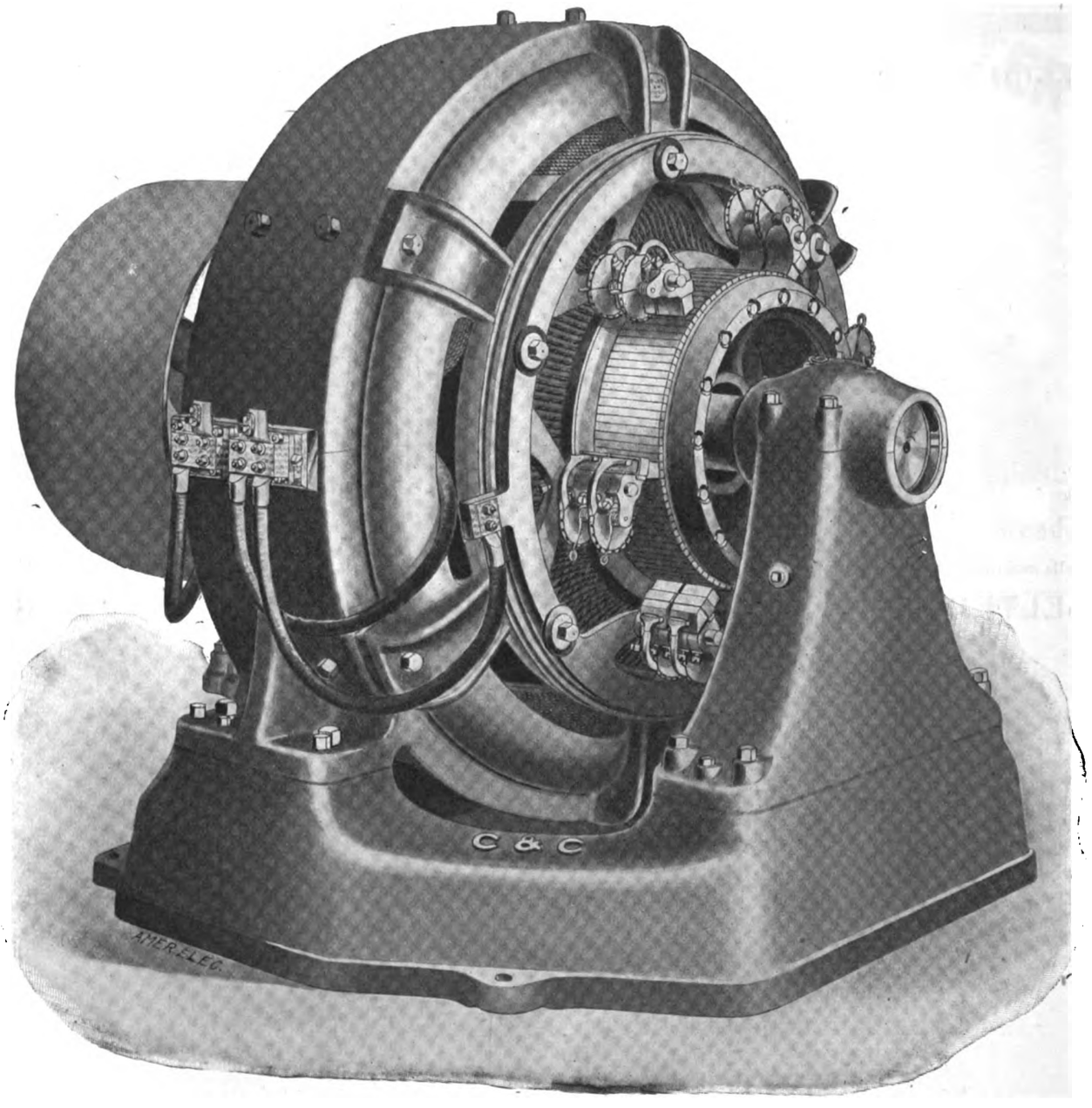
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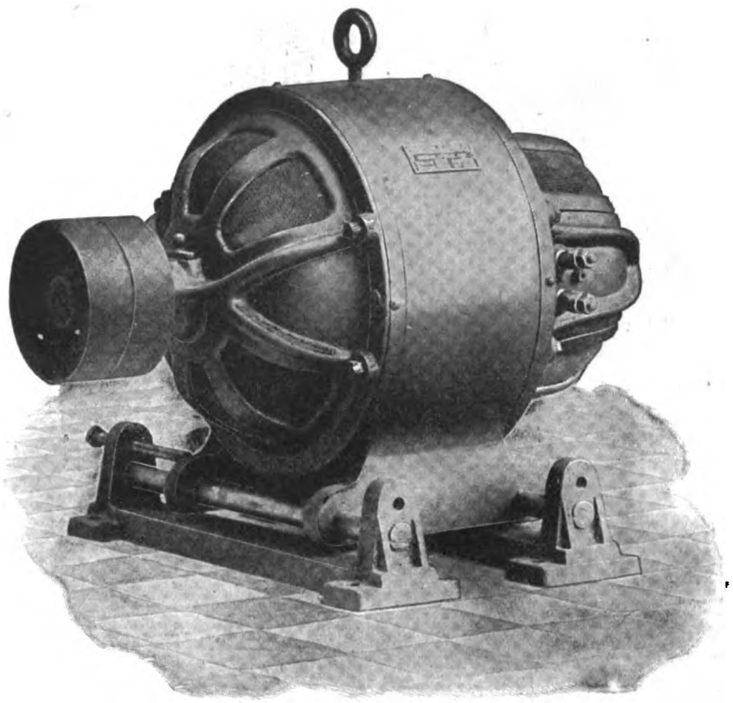
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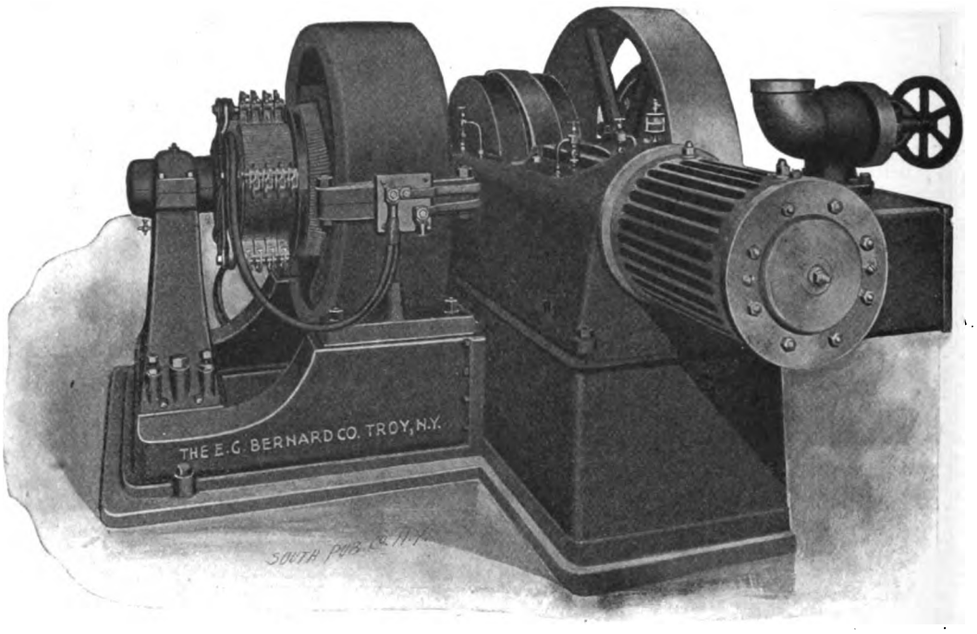

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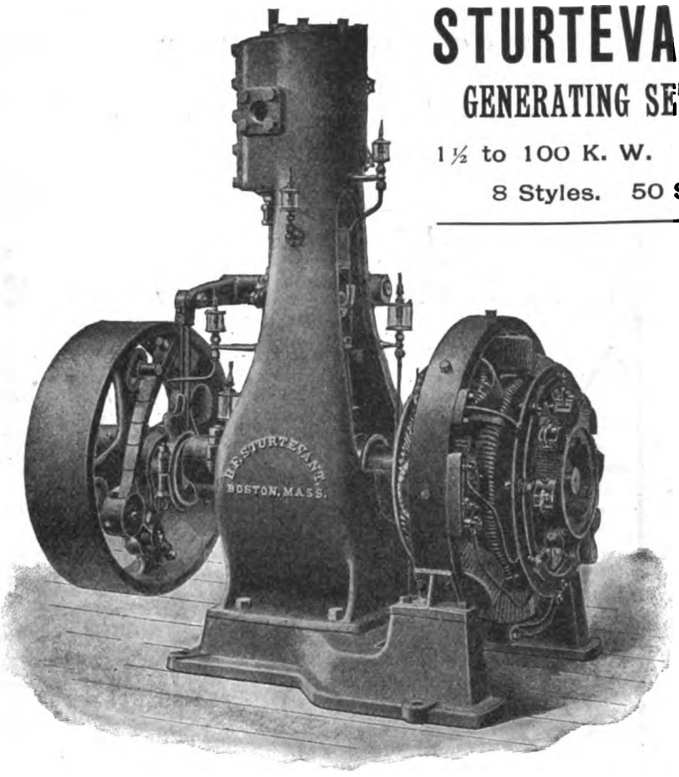
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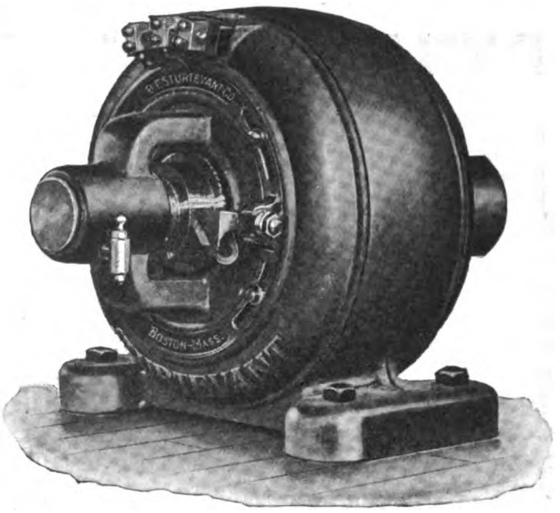

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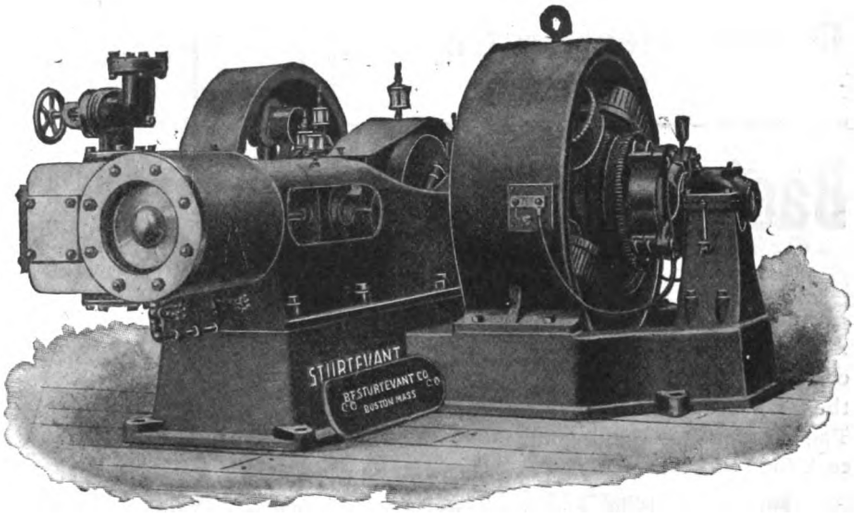


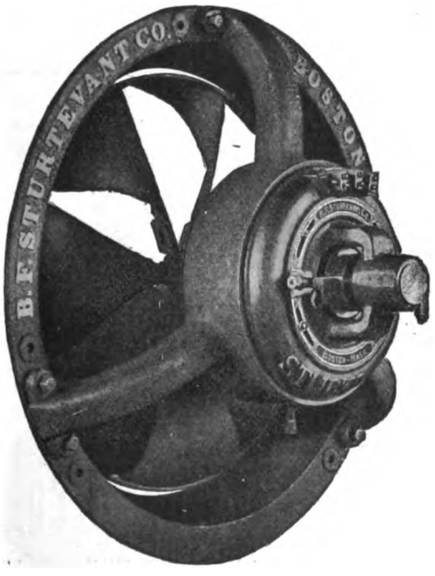

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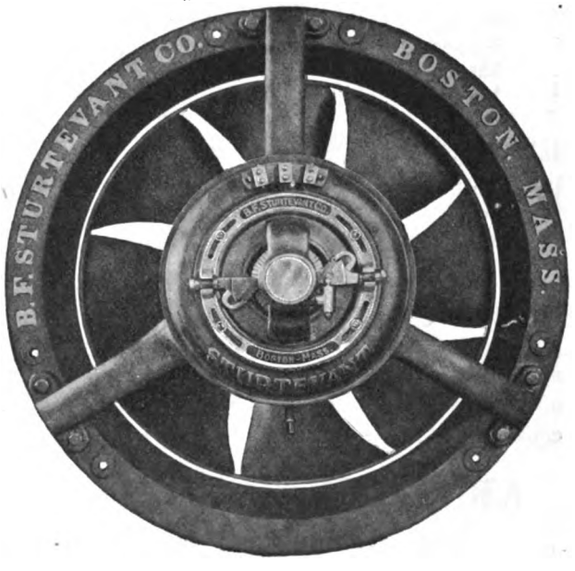




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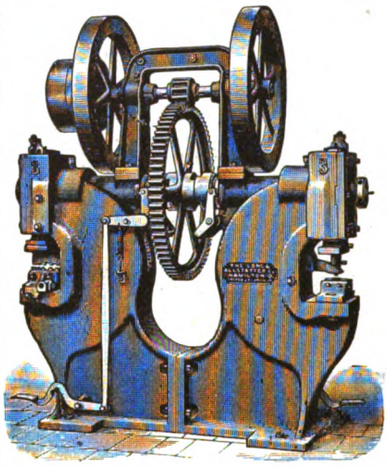
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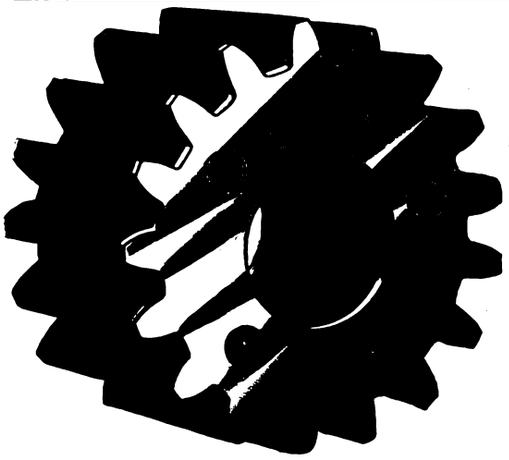
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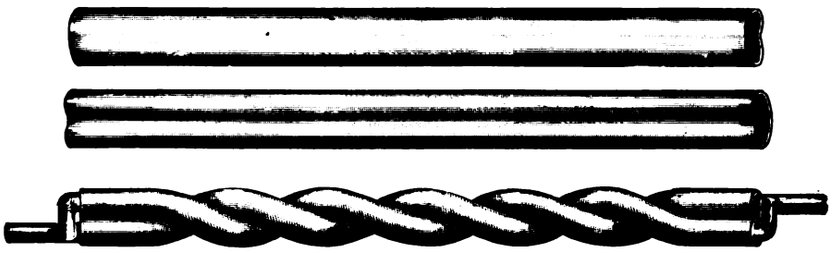
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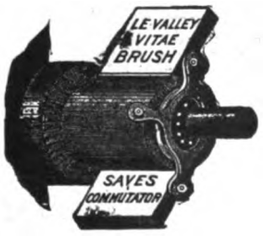



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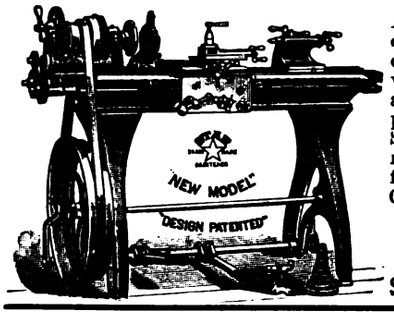
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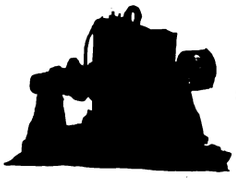
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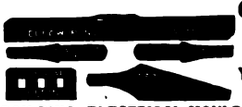
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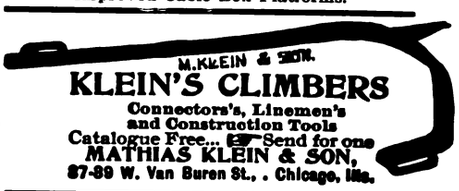


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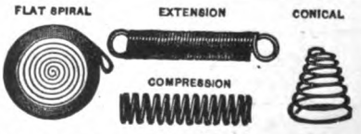
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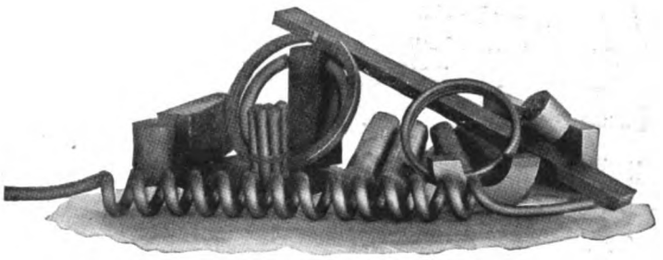
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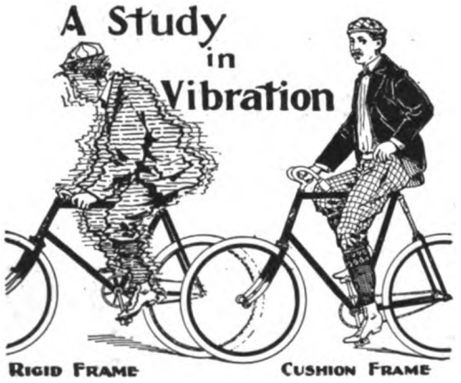
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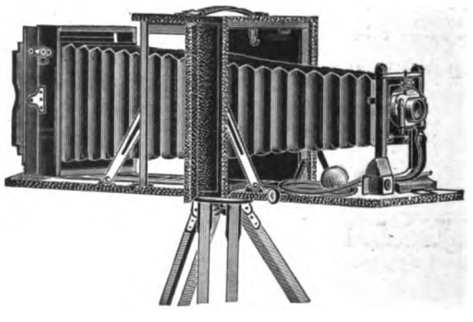
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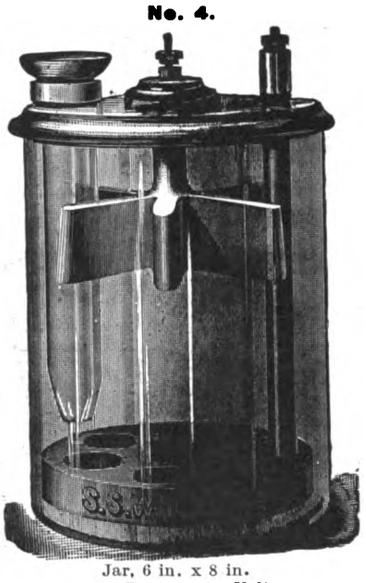
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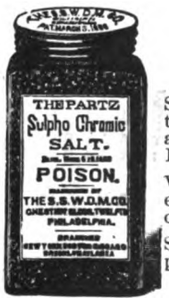
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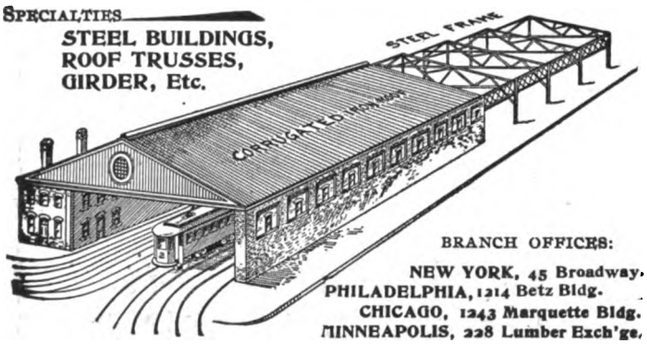
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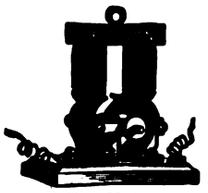

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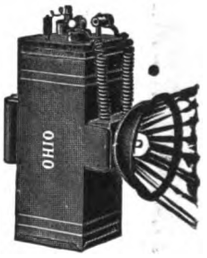
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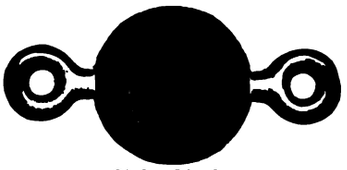
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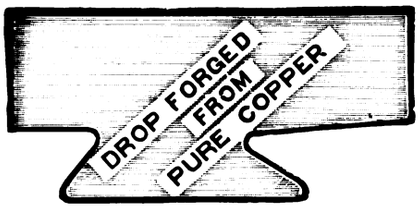


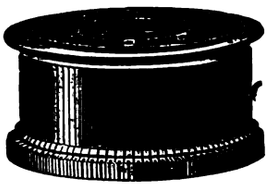
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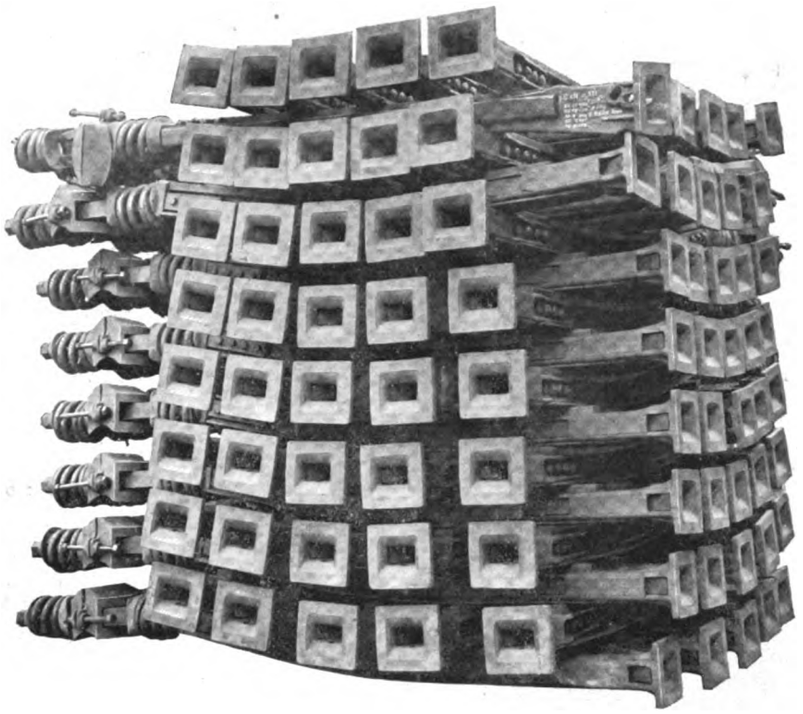
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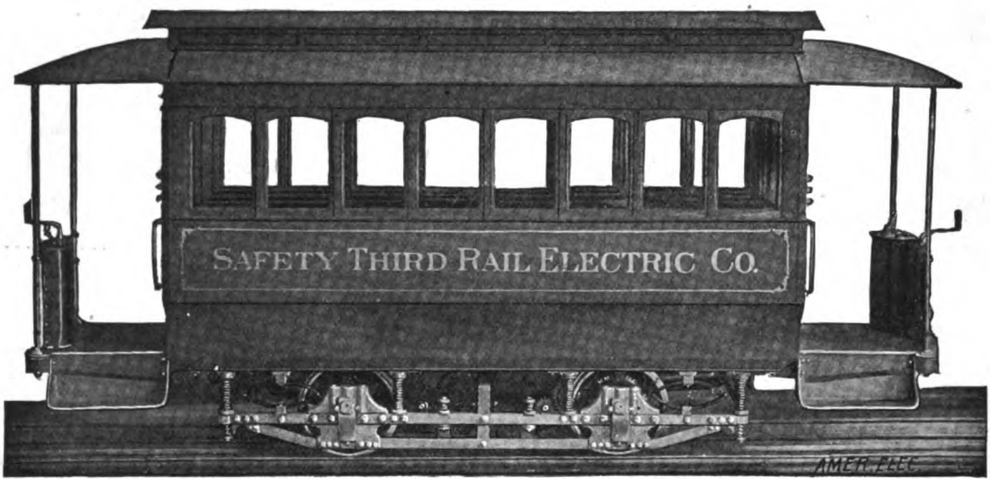
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1. Can be built for the price of a good overhead system.
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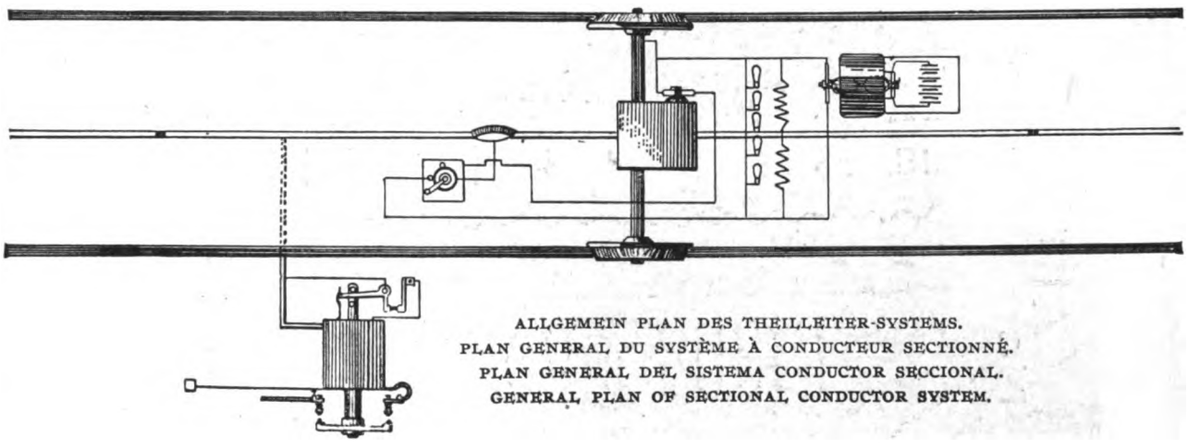
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Voir page ci-contre.

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PLAN GENERAL DU SYSTÈME À CONDUCTEUR SECTIONNÉ.
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GENERAL PLAN OF SECTIONAL CONDUCTOR SYSTEM.

Nuestro conductor del sistema seccional es absolutamente seguro para el tráfico en la superficie, no habiendo ninguna corriente eléctrica en ninguna porción de la sección del tercer riel excepto la que se halla inmediata debajo del carro.

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Enviese por prospecto elegantemente ilustrado y dando completos informes de operación.

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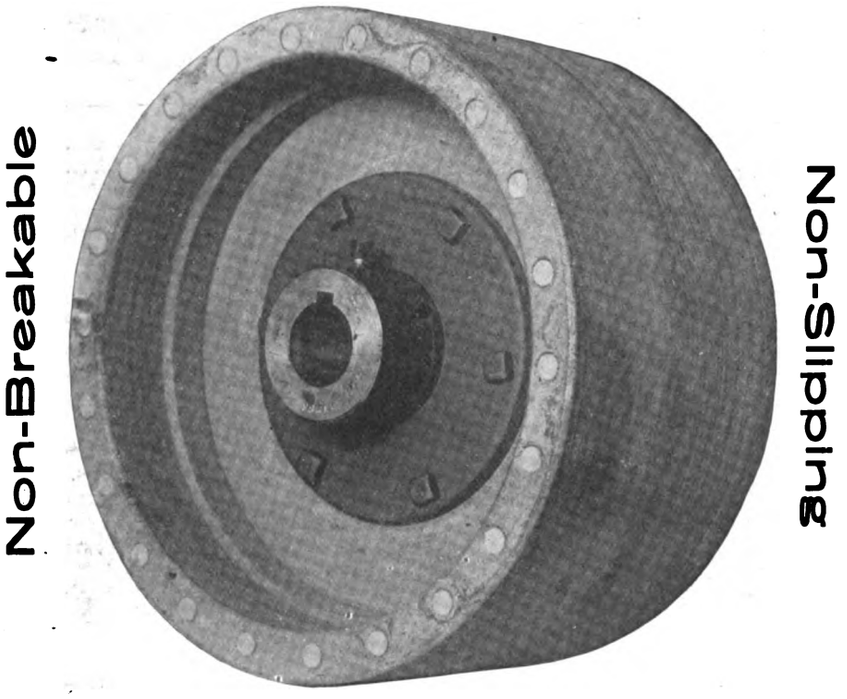
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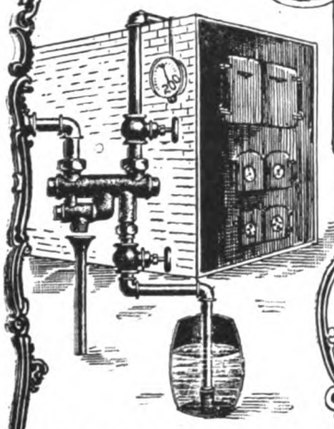
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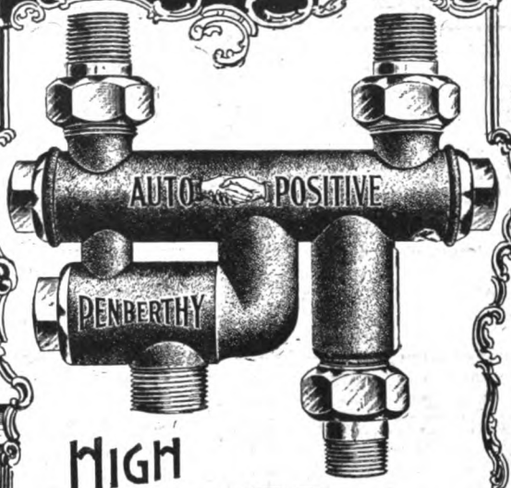
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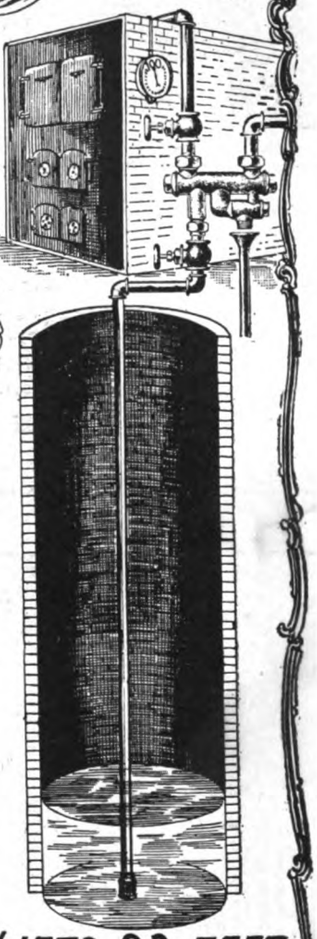
# The Twentieth Century Wonder
# The AUTO POSITIVE
## PENBERTHY



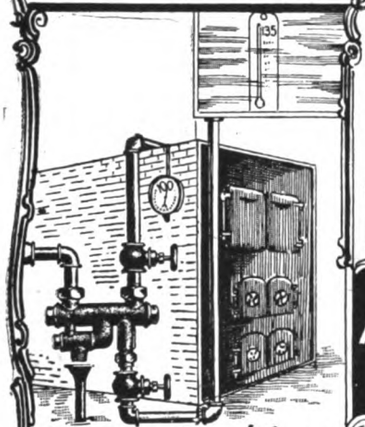
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LIFTS 22 FEET AT 100 LBS STEAM



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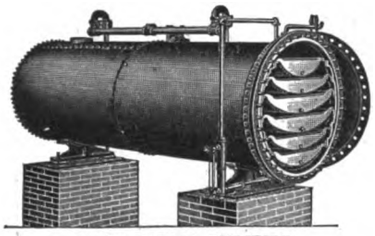
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GUARANTEED TO KEEP BOILERS CLEAN.



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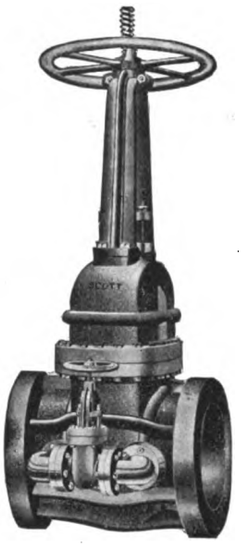
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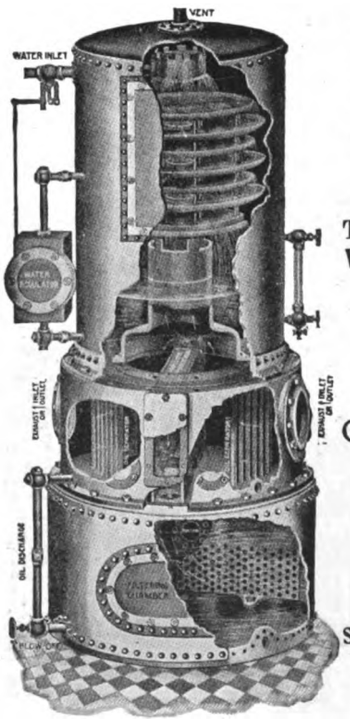
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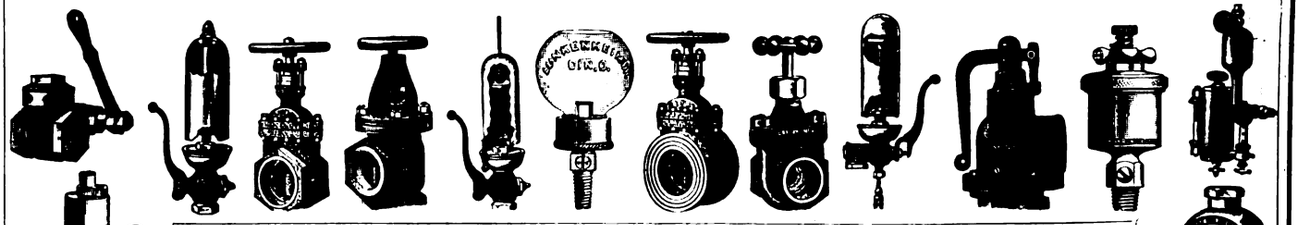
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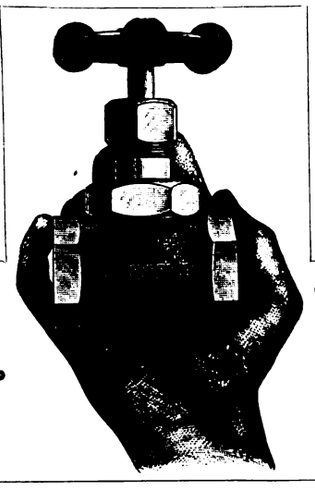
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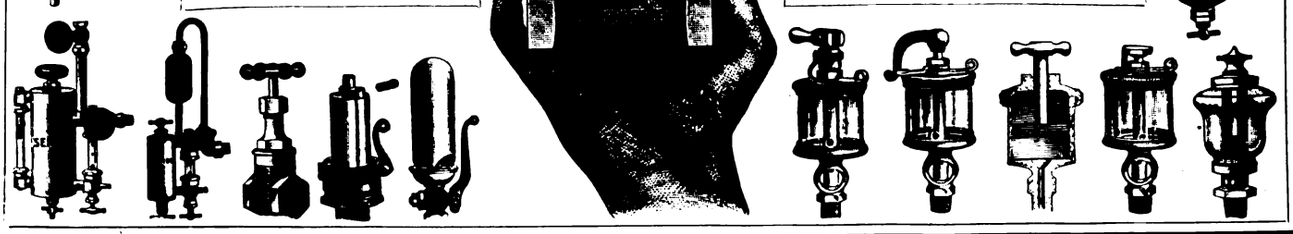
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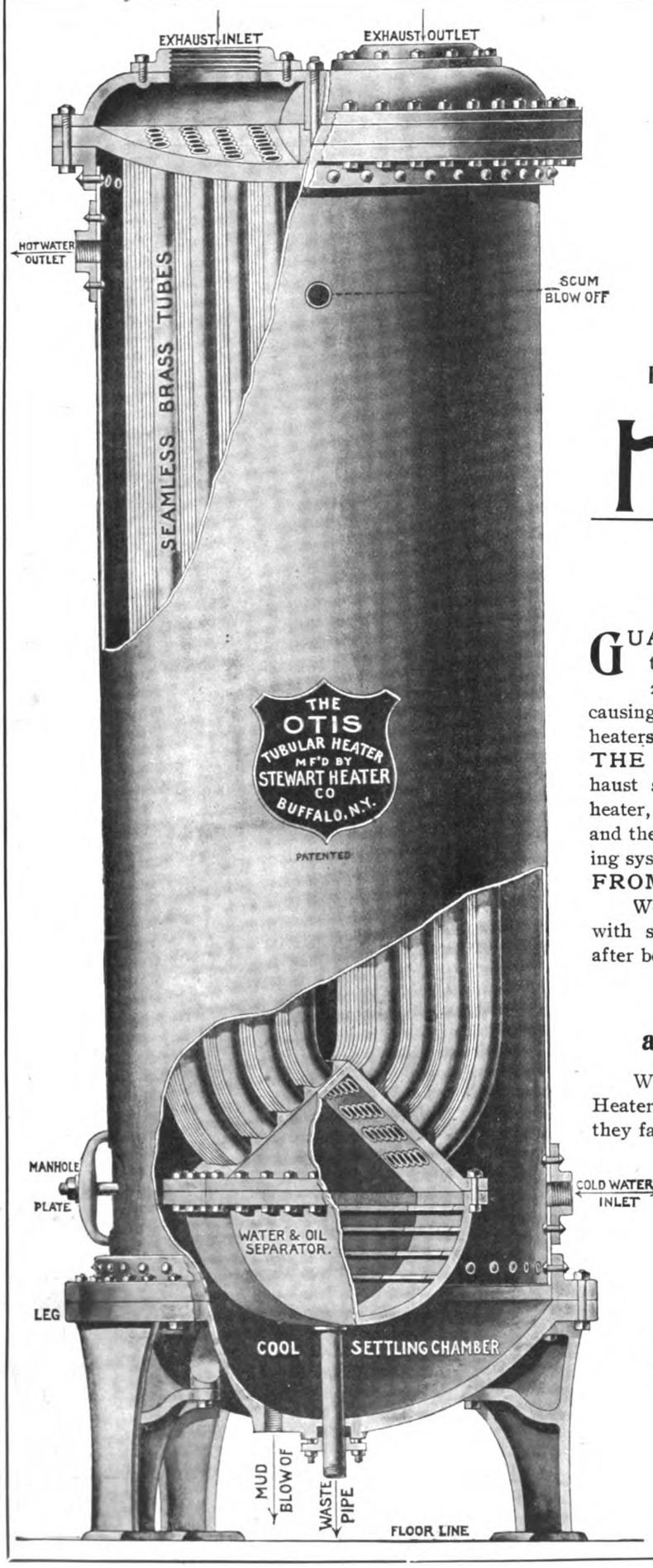


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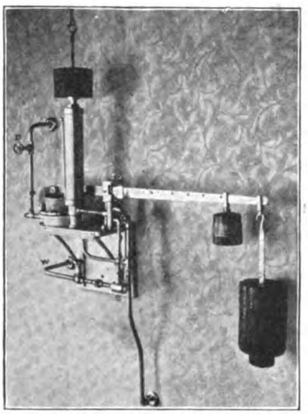
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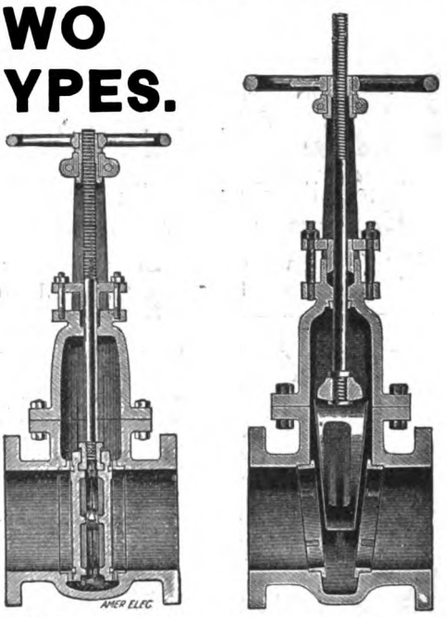
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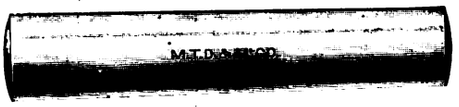

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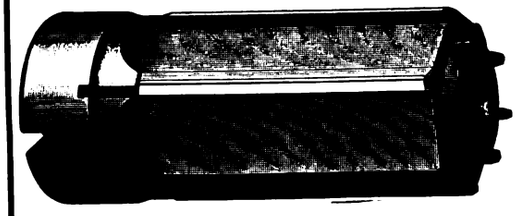
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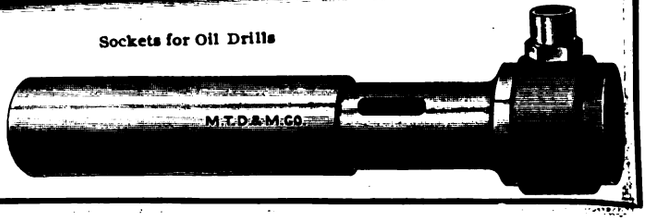

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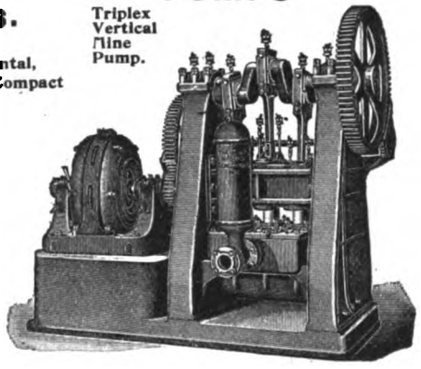
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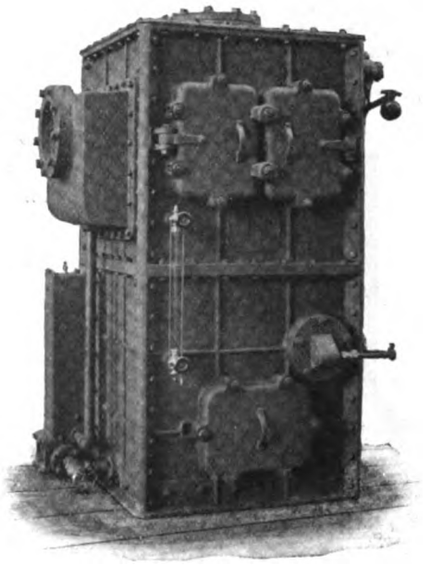


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And it is all so simple that many pass it by, or else do not believe it. But the savings can be made which we have enumerated above with a **Cochrane Feed-Water Heater and Purifier.**

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# THE TRUE COST OF A STEAM BOILER

is its original cost, plus the annual repairs. If these repairs amount to less than half a cent per Horse Power per annum, should you not take this into your calculations in comparing prices of different boilers? Below is the letter of a Boiler Maker who has repaired some of our boilers in Cuba, where the water is very bad. Read what he says and remember it when you wish to add to or improve your steam plant.

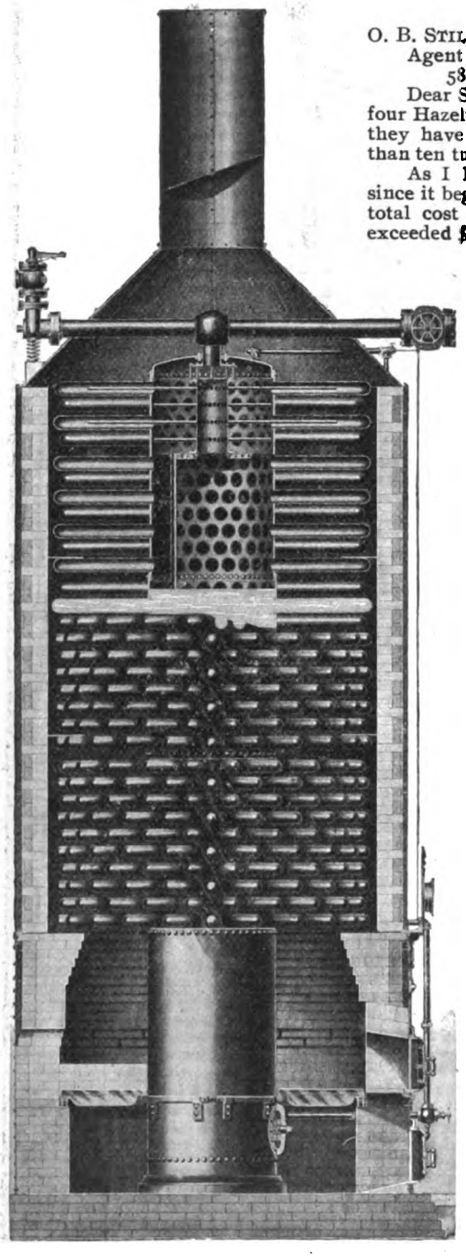
CIENFUEGOS, CUBA, April 26, 1897.

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Agent HAZELTON BOILER CO.,
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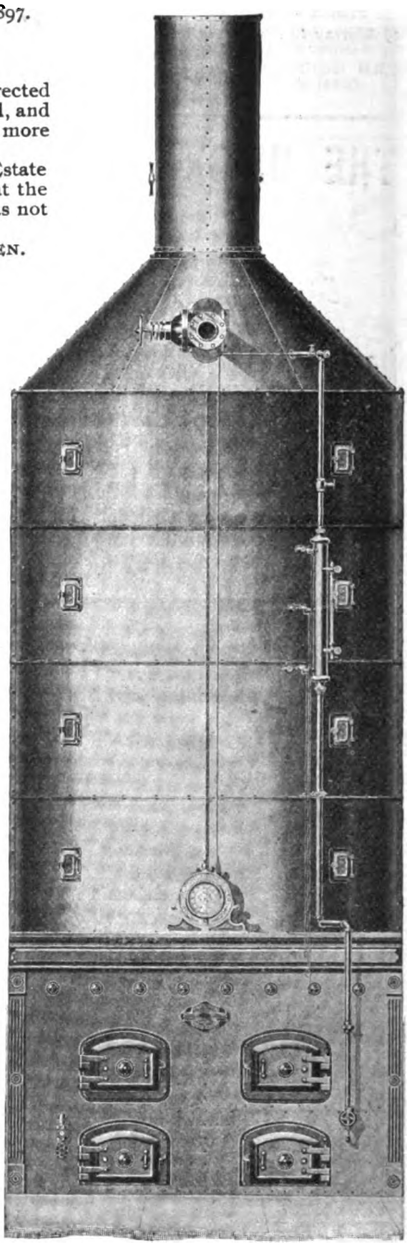
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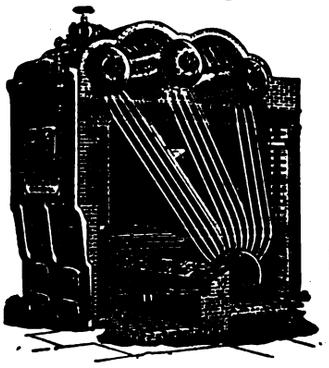
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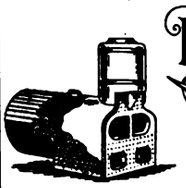
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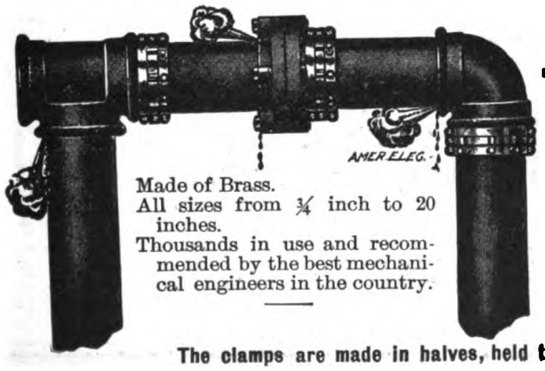
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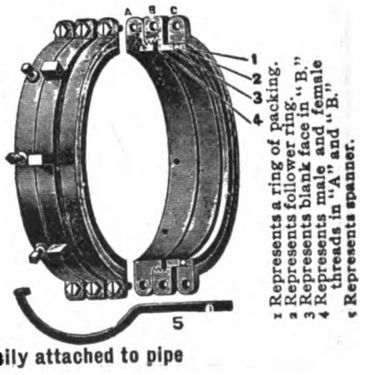
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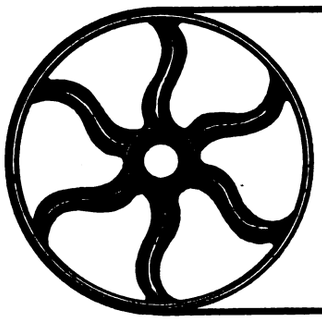
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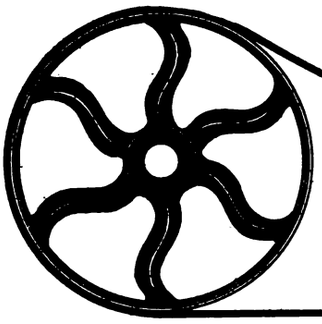



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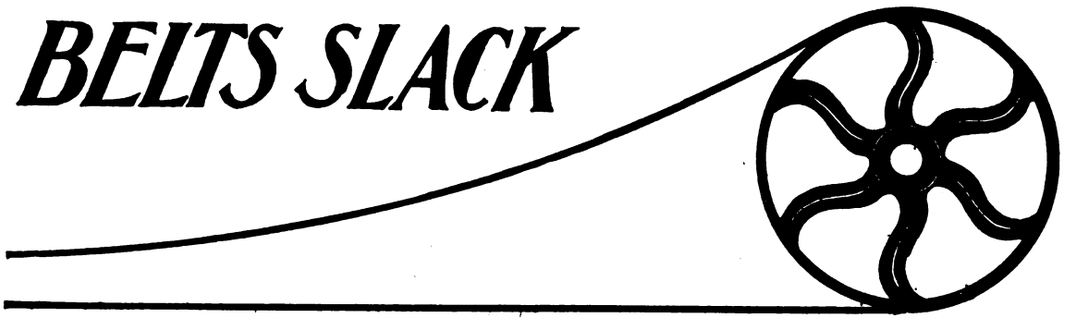
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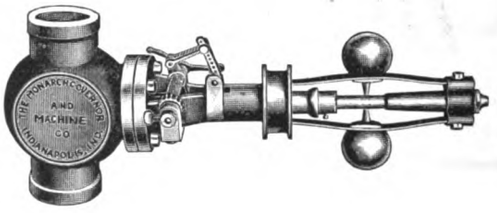
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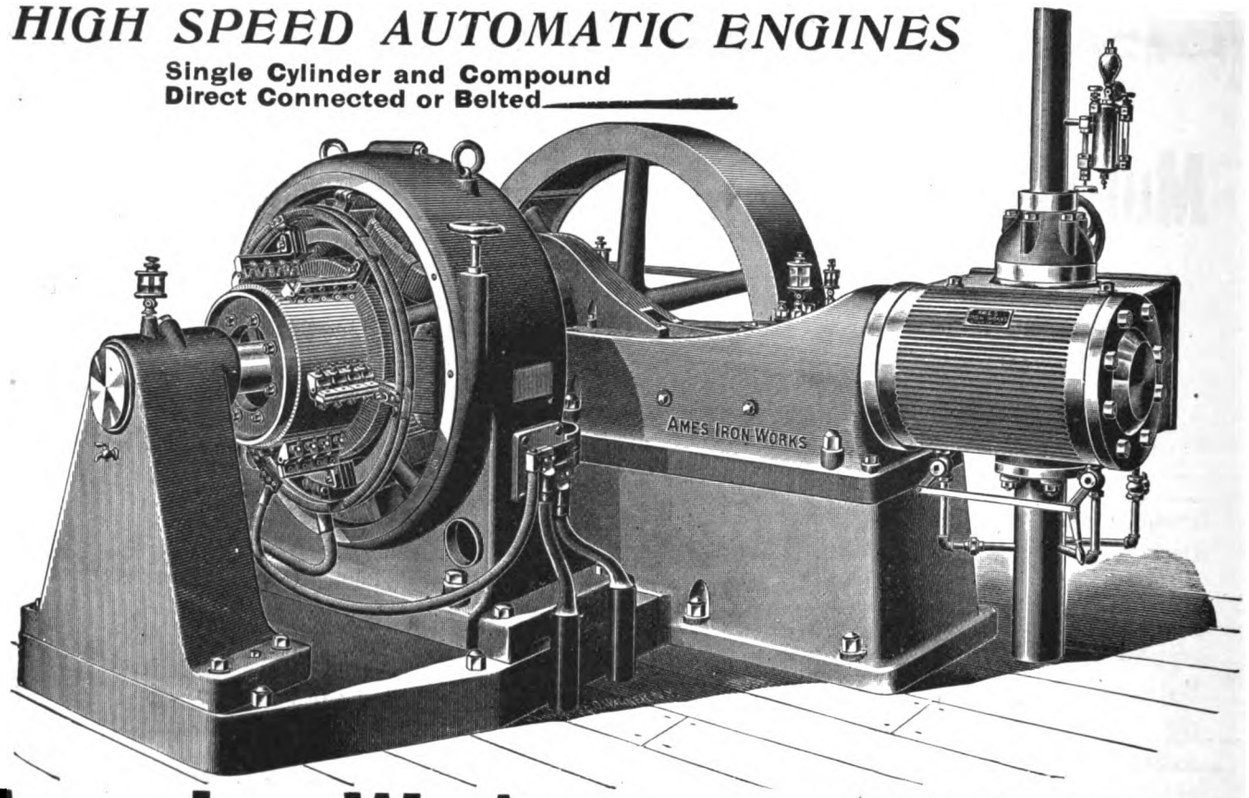
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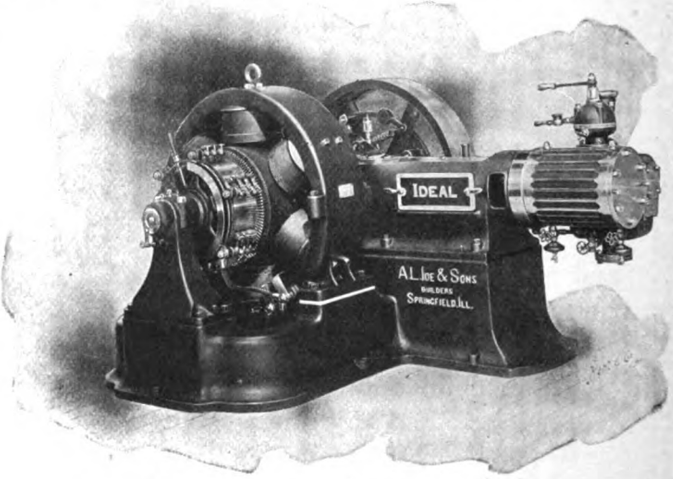

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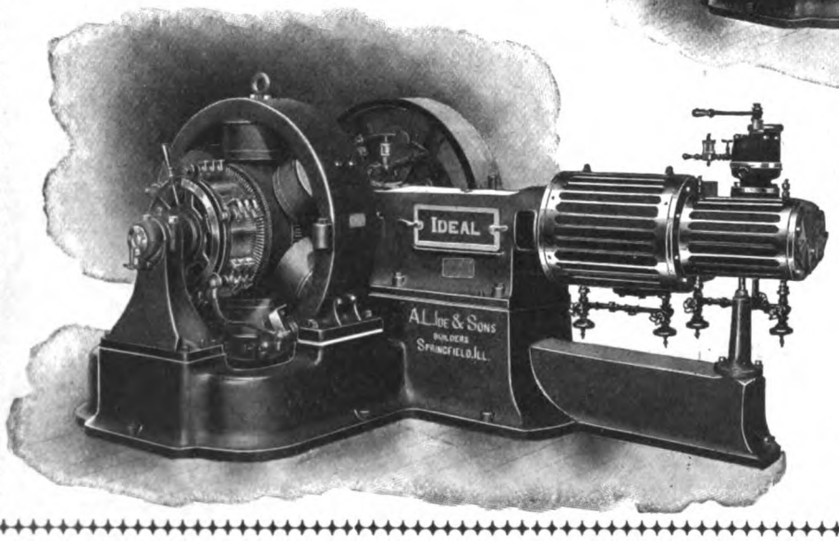
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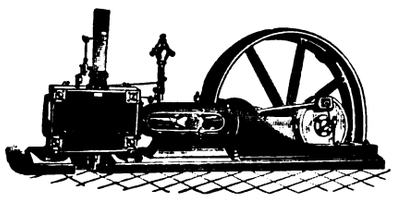
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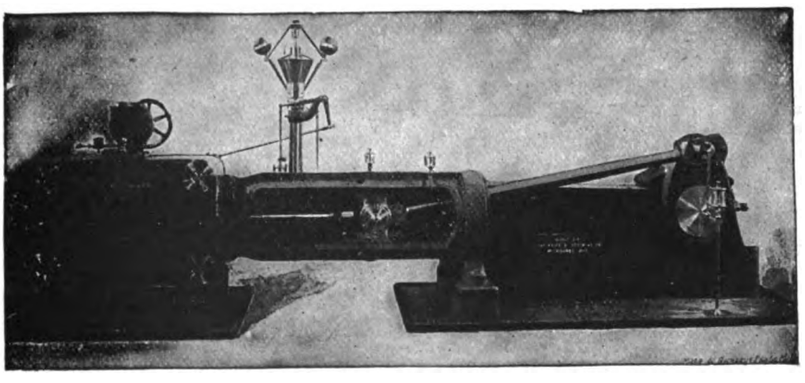
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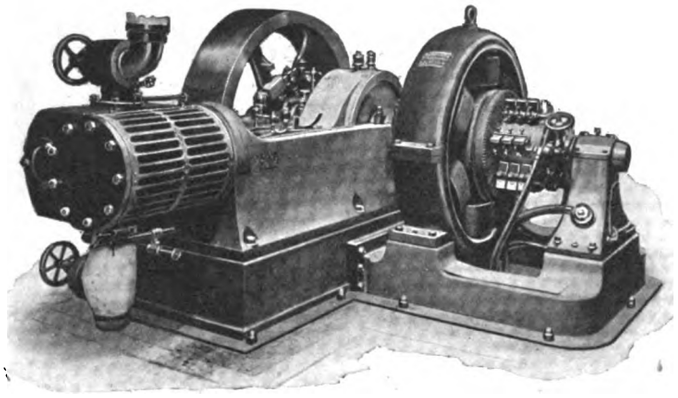

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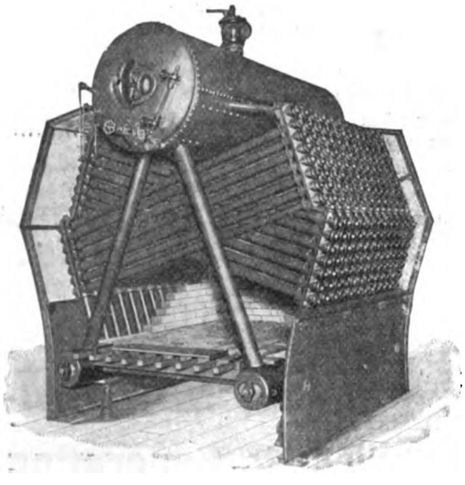
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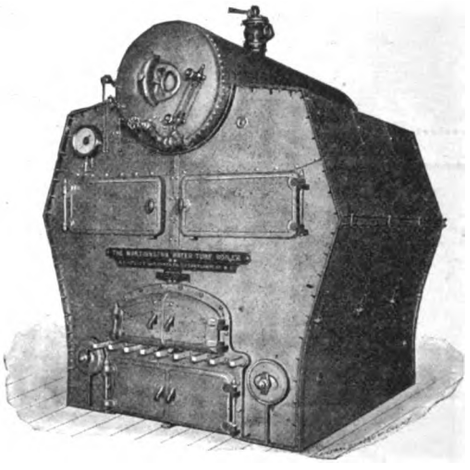


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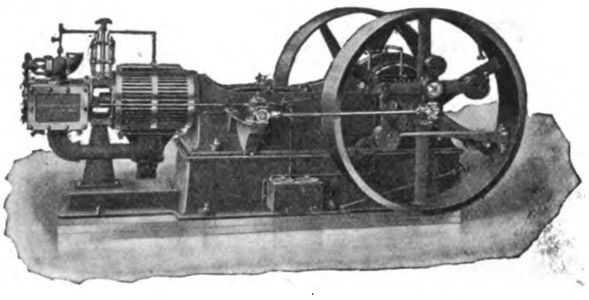


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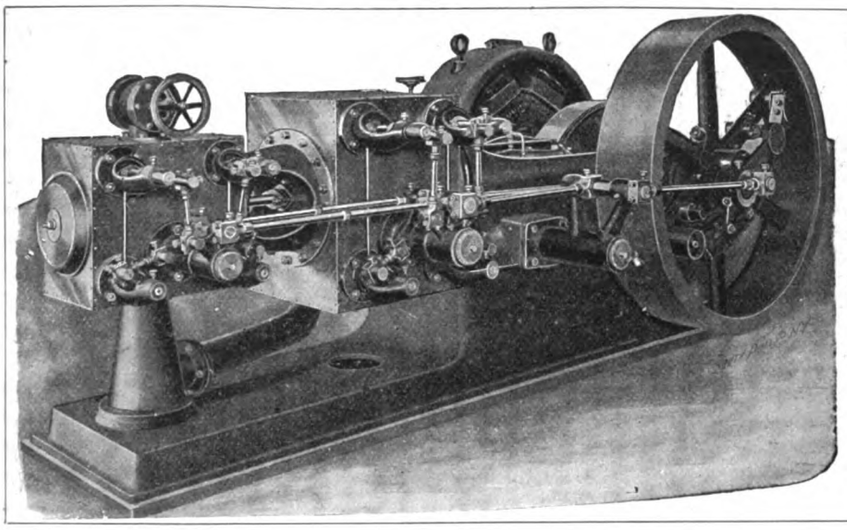
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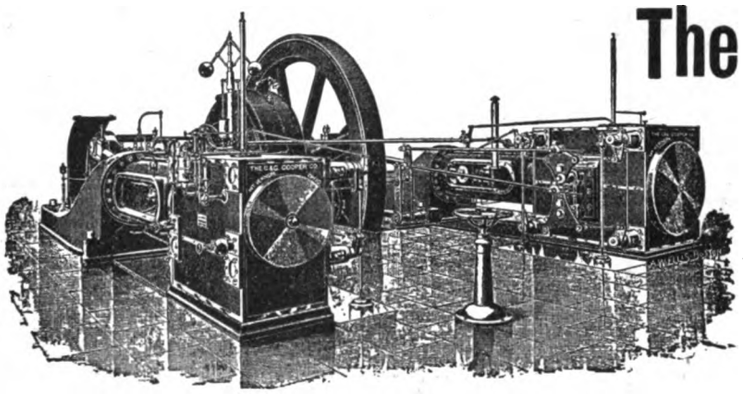
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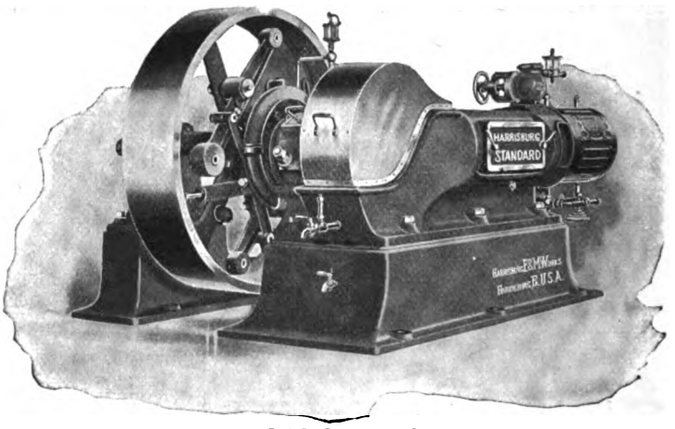
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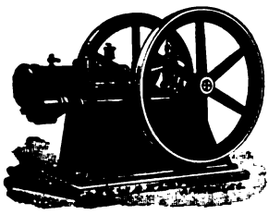

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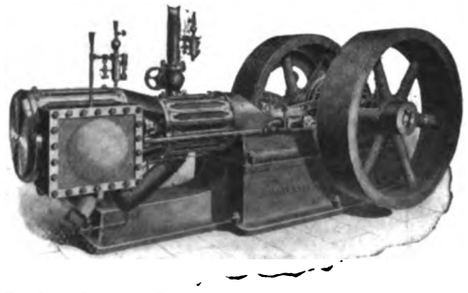
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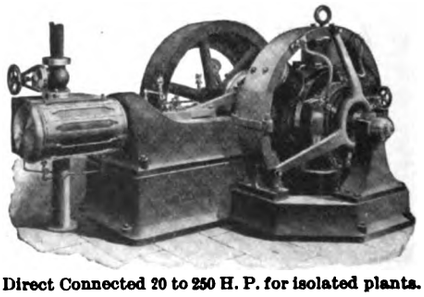
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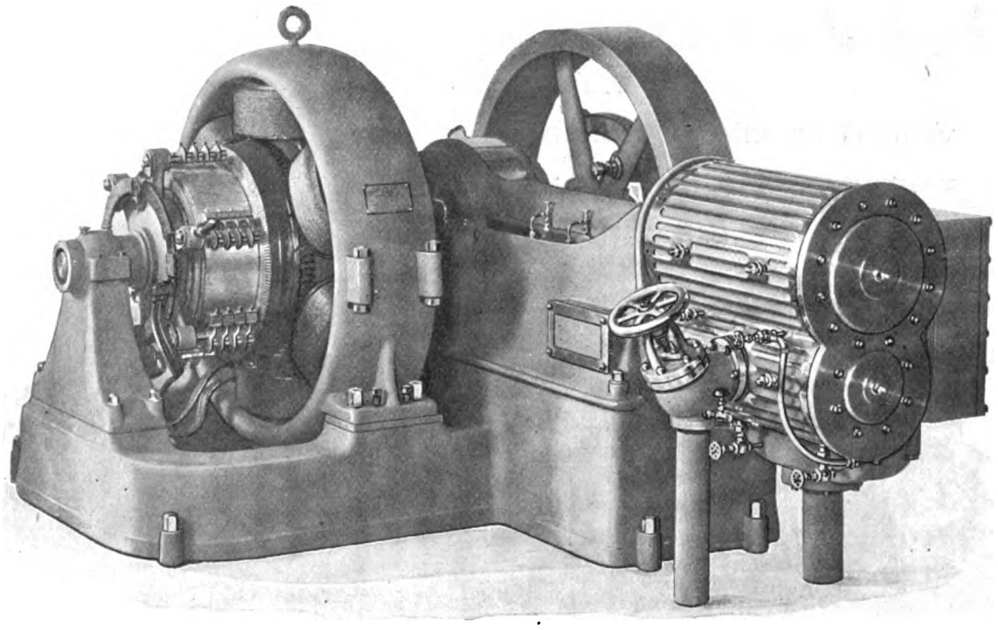

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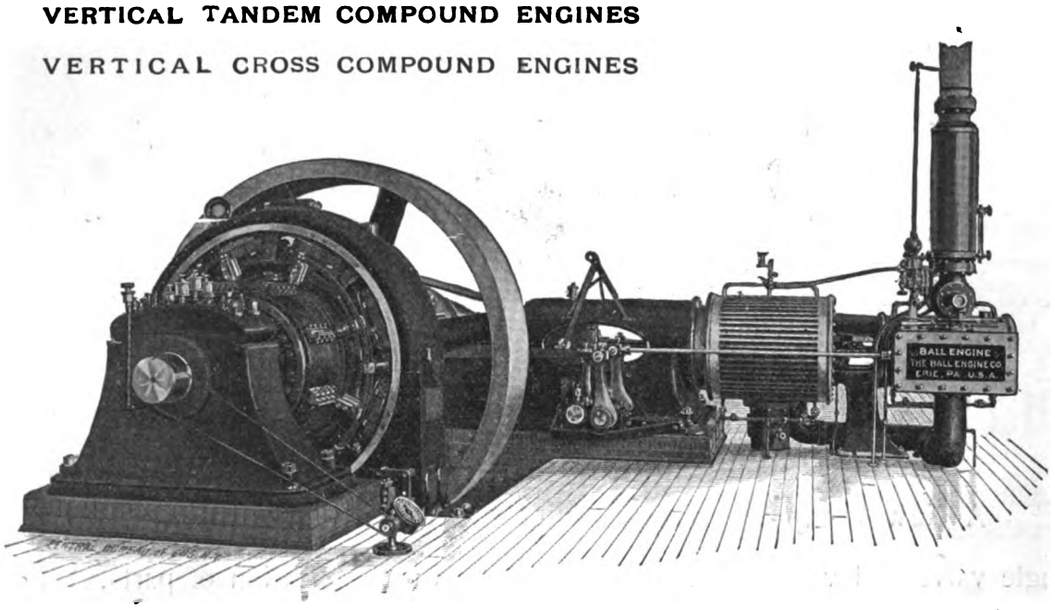

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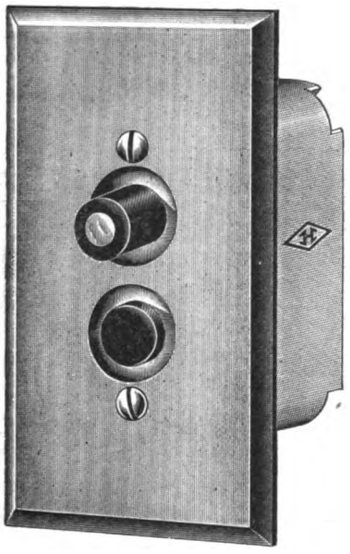
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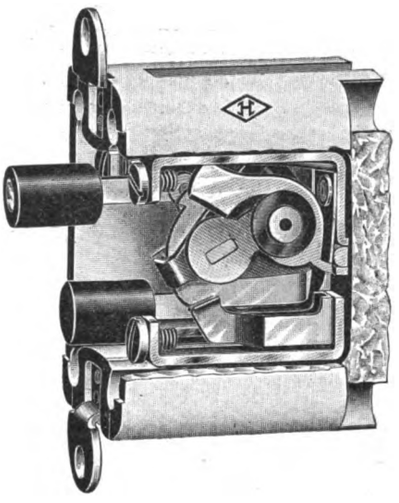


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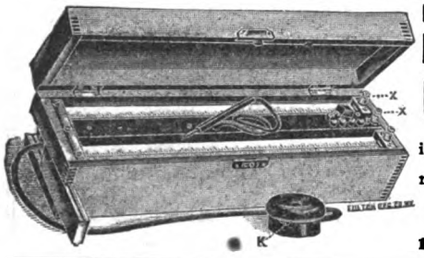
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Isolated Plant of Garrett Building, Chicago.
Electrical Equipment of Illinois Steel Works, Chicago.
Power Distribution in a Chicago Shipyard.

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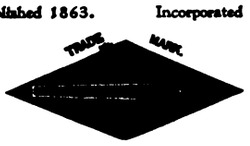
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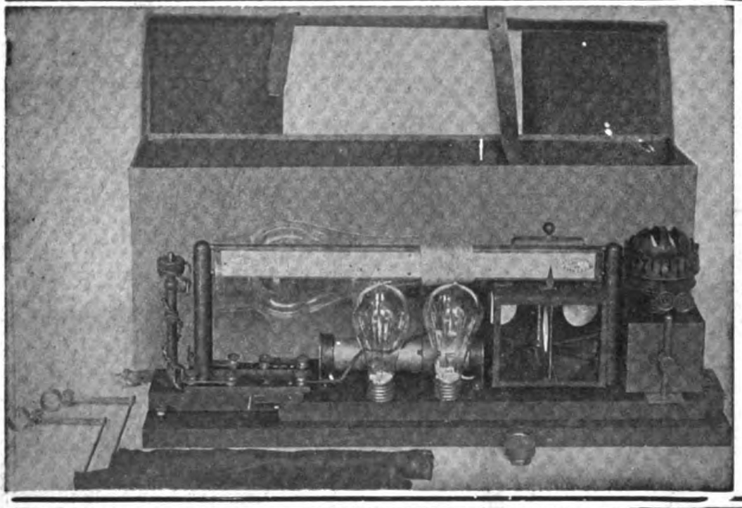

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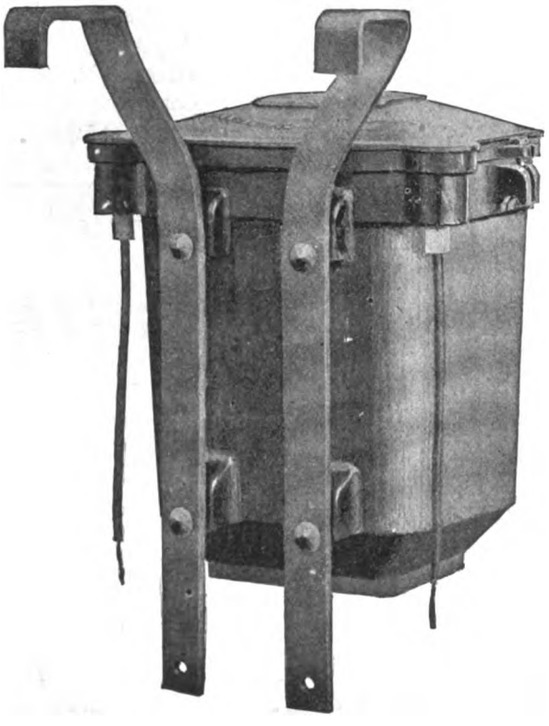
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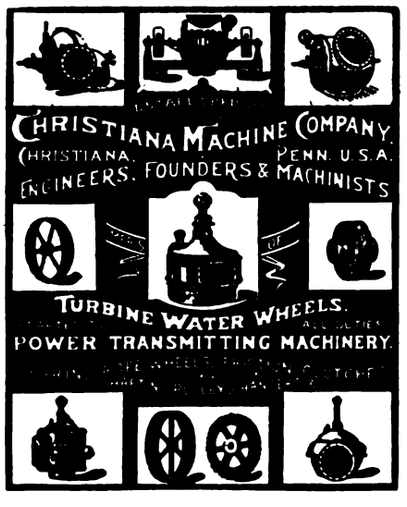
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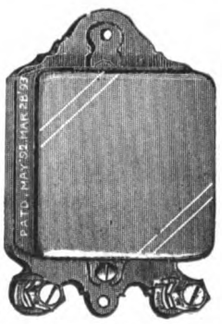
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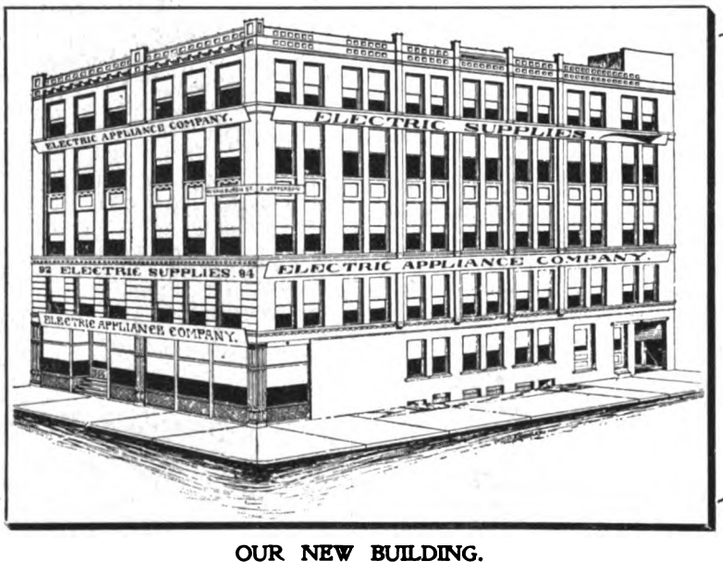
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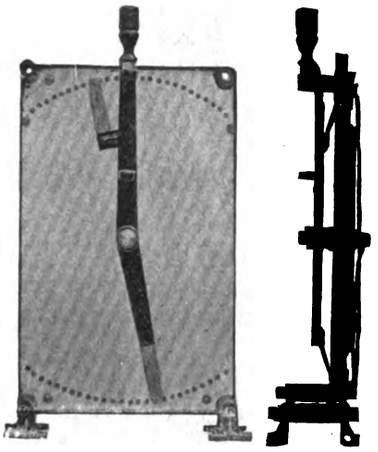
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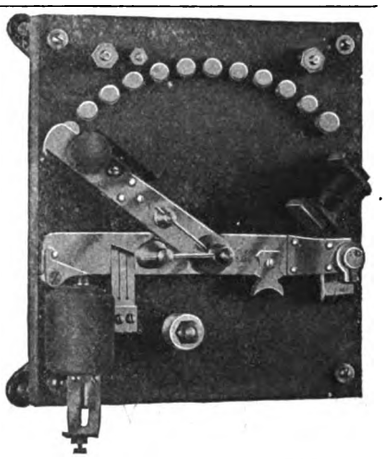

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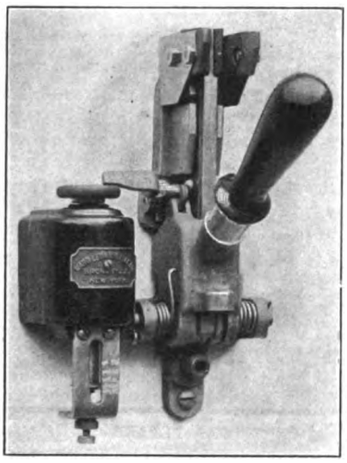
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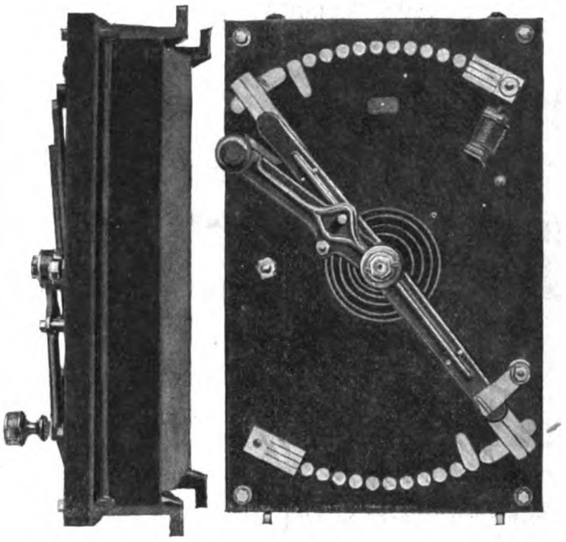
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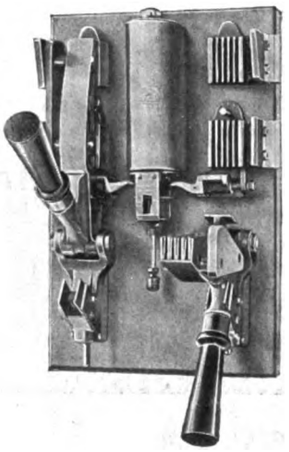


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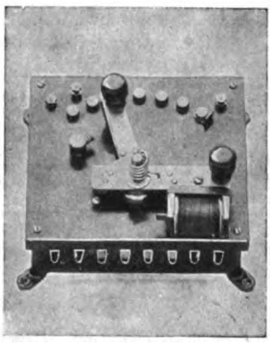


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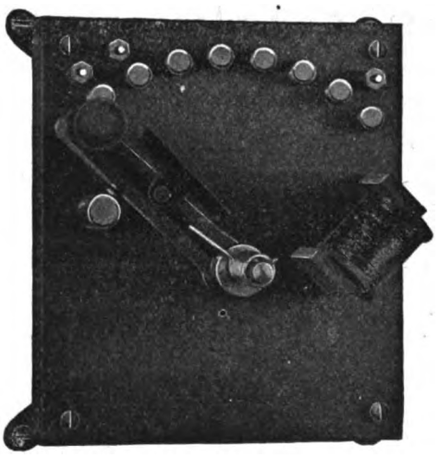
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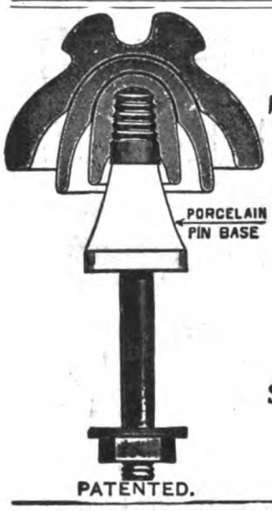
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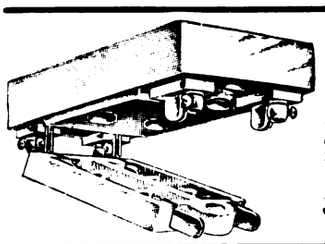
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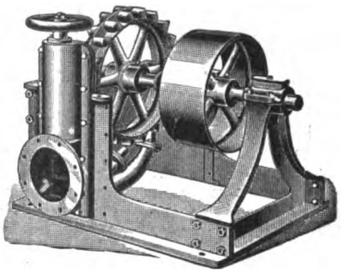
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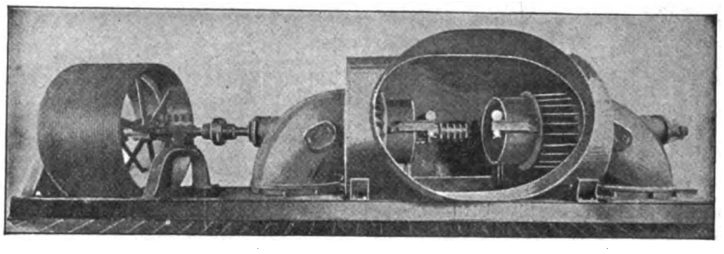
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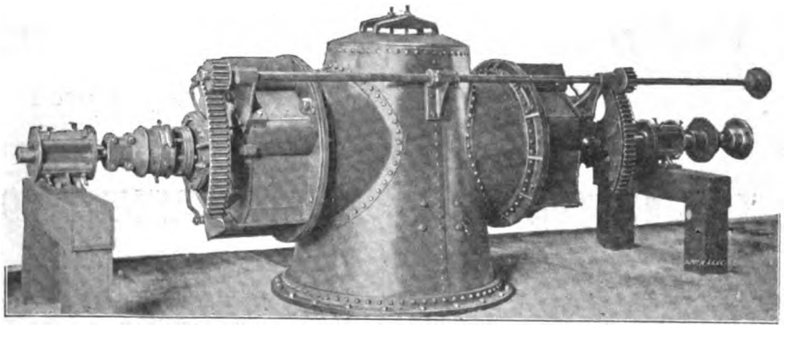


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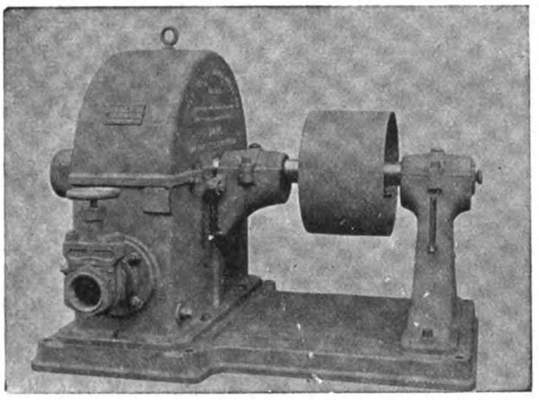
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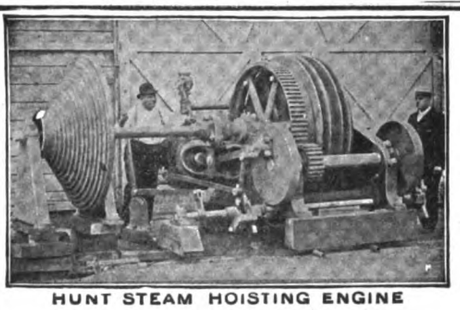
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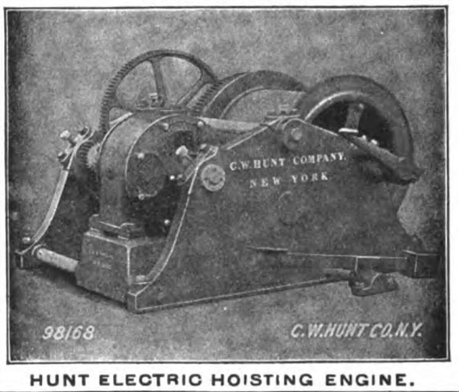
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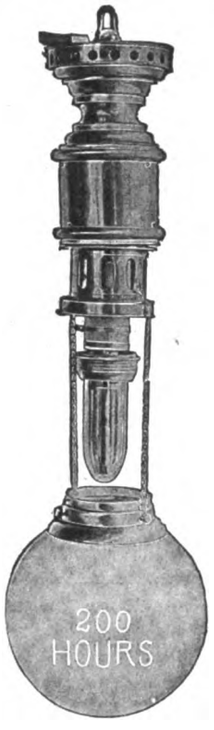
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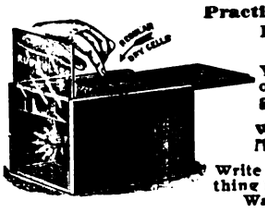
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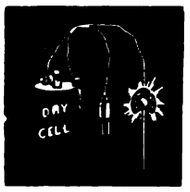
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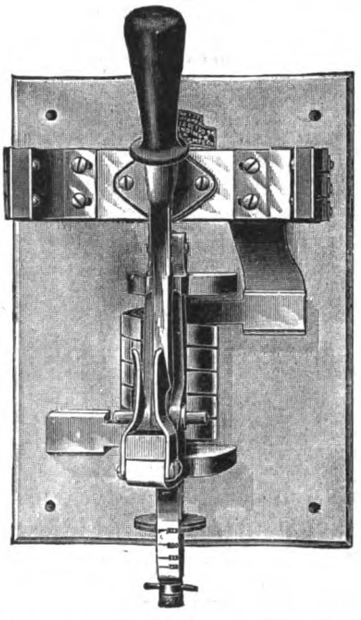
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Schiff, Jordan & Co., New York.
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**FLUE CLEANERS.**
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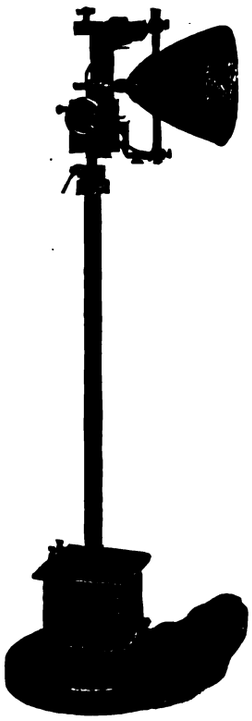


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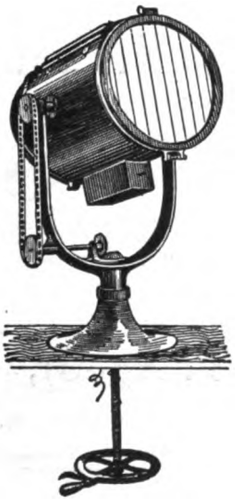
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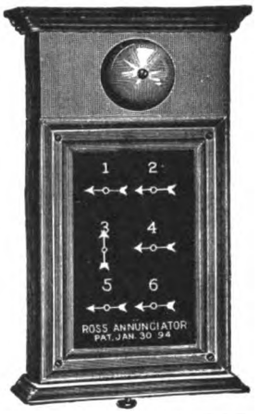
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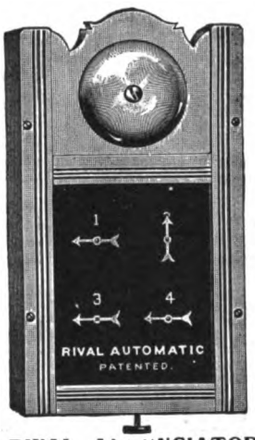



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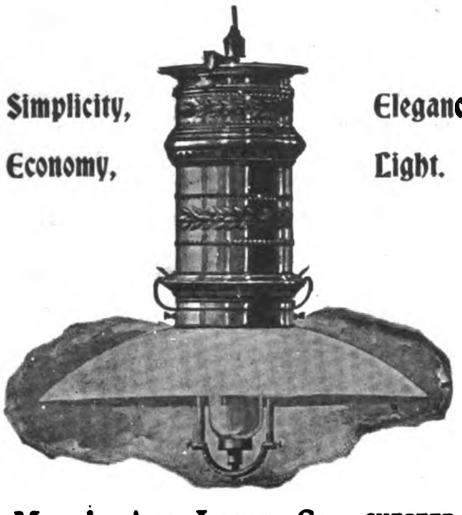

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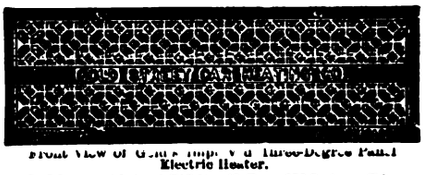
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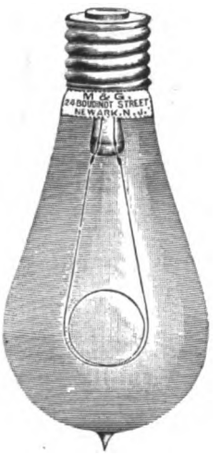
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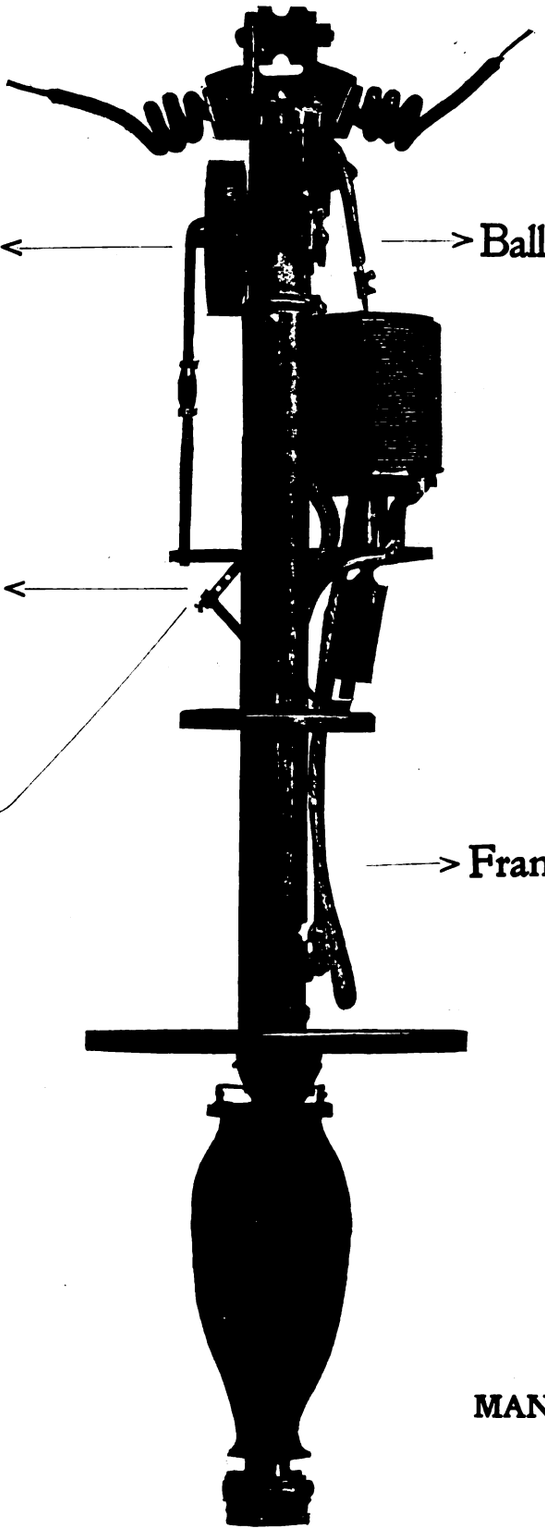
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# THE BELDEN ARC LAMP.



What do you think of a clutch that trips without striking a trip post?

See how we multiply our power by using a toggle?

Knife edge joints.

Ball Bearings.

Frame built like a Bicycle.

Trims as easy as an open Arc Lamp.

MANUFACTURED BY

See descriptive article in this number.

SEND FOR CATALOGUE.....

**Belden-Larwill Electric & Mfg. Co.,**

Fort Wayne, Indiana, U. S. A.


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# "MIDGET"

# Enclosed Arc Lamp

...FOR...

## CONSTANT CURRENT CIRCUITS.



**For** Street Lighting and Commercial Lighting

Is more economical in operation than any other constant current enclosed arc lamp on the market.

Will burn 125 to 150 hours with one 12 x ½ inch solid carbon.

Has been successfully used all over the country for more than two years by electric light stations and large corporations.

Burns on circuits of from 5 to 7 amperes without any change in adjustment. All other makes of constant current lamps require readjusting.

At 5 amperes equal to 1200 C.P. open arc lamp.

At 6.8 amperes equal to 2000 C.P. open arc lamp.

Gives steady white light, with no noise, flashing or dropping of sparks.

Where desired, we furnish a positive cut-out of compact and improved design.

For indoor service the single globe lamp can be furnished. For street service a metal reflector can be furnished in addition to the double globe.

**Full particulars, Circulars and Prices, furnished on application.**

## STANDARD THERMOMETER and ELECTRIC CO.,

**PEABODY, MASS., U. S. A.**


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# FRINK'S PATENT SPECIAL WINDOW REFLECTOR.



Patented April 20, 1897.
No. 581,093.

## FORTY YEARS OF LIGHT.

NINETY-NINE per cent. of store windows are imperfectly lighted, and especially so where electric lamps are used. Most of the lamps are scattered on the bottom and at the sides of the windows, where they can be seen by lookers in, and where they attract more attention to *themselves* than to the goods they are imperfectly lighting. The *ideal* window light should light the *goods* and not be seen while doing so.

**FRINK'S SPECIAL PATENT WINDOW REFLECTOR** for Electric Light, lined with Silver-Plated Corrugated Glass, is placed in top of the window near the front glass, reflecting the light inward and downward. This makes a very desirable window reflector, as the reflectors are put out of the way and concealed from view, at the same time concealing the direct light from the eyes of the observer, and giving a strong, even light down where wanted, thus doing away with the annoyance of a dazzling light in the eyes. We strongly recommend this style of reflector as the very best store window light in existence, and it has been adopted by leading stores in the principal cities in the U. S. It is used also largely for lighting Art Galleries, Pictures, Stock Exchange Boards, Border Lights, Telephone Switchboards, etc.

**We will consider it a favor if contractors and supply houses will send us the names of parties using or about to use an imitation of this reflector and by whom installed.**

To get results, Reflectors should be used entire width of window, with lamps 9 or 12 inches apart, as desired.

THE FIRST PRIZE AT THE FIRST GREAT AMERICAN EXPOSITION. THE FIRST PRIZE AT THE LAST GREAT WORLD'S FAIR.

....*Book of Light, Price Lists and Estimates Free*..... ◆ TELEPHONE. "860 FRANKLIN." CABLE ADDRESS. "FRINK, NEW YORK."

LICENSED TO MANUFACTURE ELECTRIC AND COMBINATION FIXTURES.

**I. P. FRINK, 551 Pearl Street, New York.** | GEO. FRINK SPENCER, Manager.

# SAVE TIME and MONEY

BY USING OUR

# "PERFECTION"
## DYNAMO BRUSHES.

RECOGNIZED AS

## STANDARD.

IMITATED ON ACCOUNT OF THEIR MERITS.

THE ORIGINAL AND GENUINE

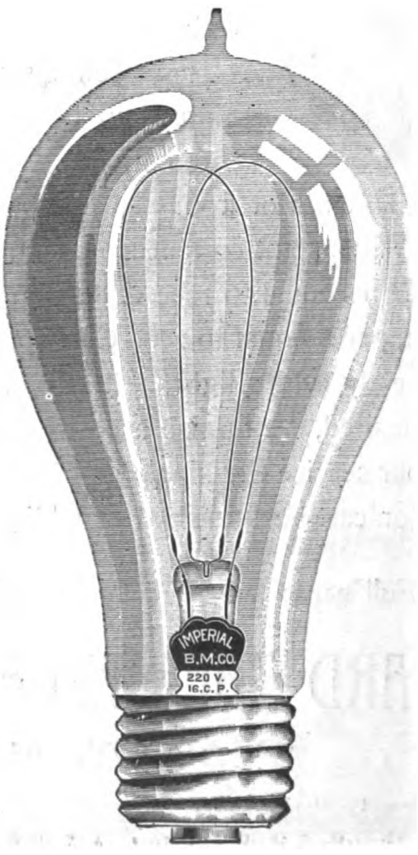
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## OHIO ELECTRIC SPECIALTY MFG. CO.,

TROY, O., U. S. A.

Descriptive Circulars and Prices on Application.

# 50 Volts vs. 100 Volts.




Low volt lamps of the same manufacture have always been known to be superior to high volt lamps. Prominent makers guarantee 13 per cent. better results from low volt than from 100-125 volts. The reason is that the former are "treated" lamps or "flashed" at a higher temperature and have a greater percentage of denser, pure deposited carbon.

**Bryan-Marsh New Double Filament Lamps** have two 50 volt filaments in series. In consequence, under specification, their guarantees of candle area are higher than any competitor, and owing to their durability, 31 watt lamps can often be used where 35 watts were formerly used.

**The Only Independent Lamp Used by Large Central Stations.**

## MICHIGAN ELECTRIC CO.

DETROIT, MICH.

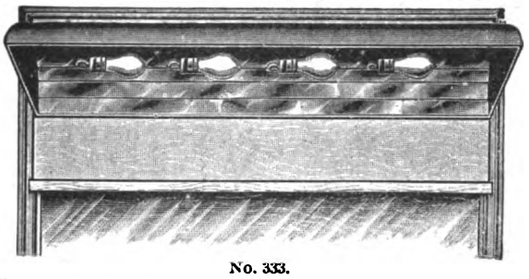

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# PARAGON REFLECTORS

ARE UNSURPASSED FOR

WINDOW LIGHTING.

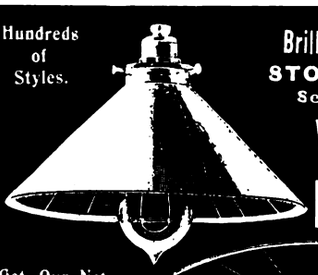


No. 333.

They can be placed to throw the light at any angle and cover the entire window with an even light. They will increase the efficiency of your window lights from 200 to 400 per cent. Made in lengths to fit any window. Send for prices and catalogue.

**American Reflector & Lighting Co., Chicago, Ills.**

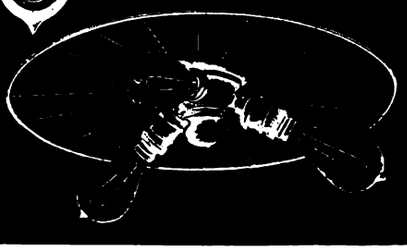
Hundreds of Styles.



Brilliant Illumination in STORE WINDOWS Secured by Using

# Wheeler Reflectors

Get Our Net Prices.



**Wheeler Reflector Company,**

Boston, Mass.



Patented.

NEW.

## Now Is the Time

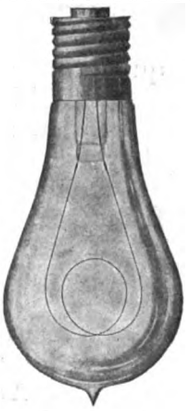
to gather up your burned-out Lamps and ship them to us for

***Renewal or Exchange .....for New Ones.***

**Long Life, Uniformity and Maintenance of Candle Power Guaranteed.**

**Write Us for Prices and Full Particulars.**

# LYNN INCANDESCENT LAMP CO., LYNN, MASS.



RENEWED.

# A.C. SERIES Enclosed Arc System. MANHATTAN

Power Factor Complete Circuit Series Lamps with regulator, .50.

**MANHATTAN REGULATING REACTANCE COIL.**

Regulator loss constant at all loads **200 watts.**

Regulators to provide for any percentage of circuit from 10 to 100 per cent.

## Manhattan Series A. C. Enclosed Lamps.

**At 6.6 amp. 72-volt arc, 430 watts. Total loss in lamp, 5 watts.**

**Power Factor .91. Efficiency .99. Terminal and arc voltage the same.**

**Concentric Mechanism; but one magnet used in lamp. No Springs. Electrical Cut-out.**

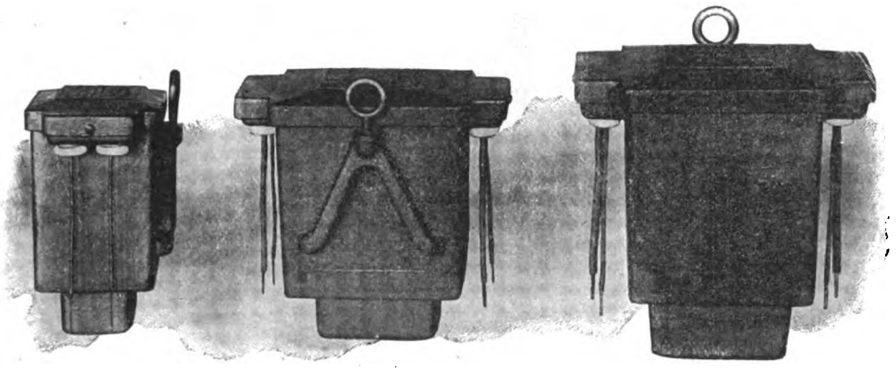
## Manhattan General Construction Co.,

**SALES OFFICE, 11 BROADWAY, NEW YORK.** **NEWARK, N. J.**


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# HERE IS A PICTURE OF A TRANSFORMER.

It is similar in principle and appearance to all other transformers. It has a primary, a secondary, and an iron core just like all the rest.



Why is this transformer better than any other?

Here are two reasons:

It is insulated highly.

Its iron core is of the best grade for the purpose, and there's a difference in irons.

Good iron requires little magnetizing current and stays cool.

Good iron costs money. The demand for it is great; it is hard to get.

Good iron is used in Royal Transformers. They don't ***look*** any better for it, but they are not sold on looks.

Good insulation also, like good iron, does not show on the surface, but in the performance.

You can't determine the relative merit of Royal Transformers by looks, catalogues, or advertisements. What then? By a sample order.

## ROYAL ELECTRIC COMPANY,

MAIN OFFICE AND FACTORY, PEORIA, ILL.

MANUFACTURERS OF
**Alternating Current Generators and Transformers.**

# SWITCH BOARDS



Generator Panels,
Feeder Panels,
Distribution Boards,
Knife Switches,
Automatic Switches,
Lugs, Connections, Etc.
The Z & H Flush Plug-Receptacle.

SEND FOR GENERAL CATALOGUE and BULLETINS

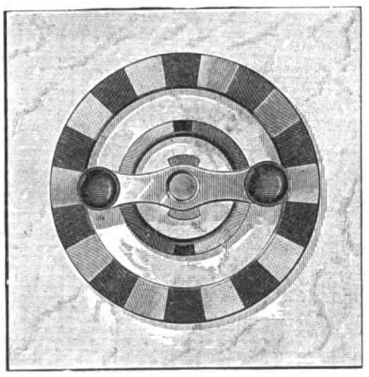
## ZIMDARS & HUNT,

....MANUFACTURERS OF....

Electric Light and Power Specialties,

*127 FIFTH AVENUE, NEW YORK.*

CHICAGO:
Badt-Goltz Engineering Co., Monadnock Block.



**MABBS' Ammeter and Voltmeter Switches and Ground Protector.**

A radical improvement in switches.

Perfect contact and absolutely uniform resistance for all contacts.

**J. W. MABBS,**
Board of Trade Bldg.,
CHICAGO.

## Reversing Controllers.

POSITIVE CAM MOVEMENT, LONG ARCING DISTANCES IMPROVED CONTACTS, FIRE PROOF RESISTANCE

FLOAT SWITCHES, SPECIAL SWITCHES, SOLENOIDS

Resistance Coils for Special Duty. Switchboards.

**H. P. WHITE & CO., 1217 Filbert St., Philadelphia, Pa.**

## McCREARY'S Patented HALF REFLECTOR SHADES.

**Glass, Aluminum, Tin.**



Opal, Red, Blue, Crystal, Green, Yellow, Silvered Glass, Green & Opal, Aluminum, Tin.

For 16 or 32 C. P. Lamps.

NEW LIST AND DISCOUNTS.

**THE A. A. McCREARY CO., 136 Liberty St., N. Y.**


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# "Quality Talks."

We make only the Finest

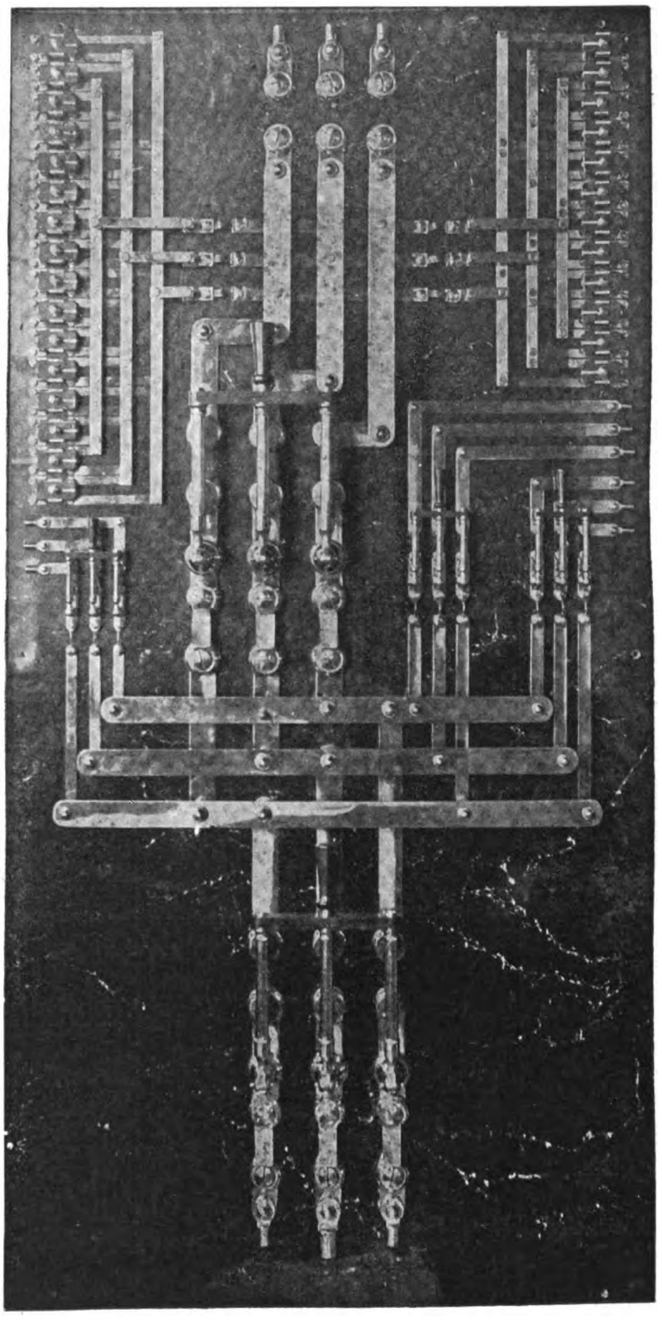
**Knife Switches,**

**Switch Boards**

and

**Panel Boards.**

*Send for Catalogue.*



We have just doubled the capacity of our factory and can now make

**Prompt Shipments.**

*SEND US YOUR SPECIFICATIONS.*

We quote right Prices on Highest Grade Work.

## Crouse-Hinds Electric Company

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BOSTON: 200 Summer Street.

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Works: SYRACUSE, N. Y.


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# The Edison, Jr., Incandescent Lamp Stands all the Tests for Efficiency, Etc. { A strictly high-grade Lamp, not in the combination.

We are Sole Agents in Greater New York.

TRY IT. GET OUR PRICES FOR BARREL LOTS.




1,000,000 sold during the past 12 months.

**Mesco Dry Battery:** Acknowledged the Best Dry Cell Manufactured.

Price each, 20c.

Standard size, 2¼x6½.

We make all sizes.



**Dittmar Pocket Battery Gauge.**

Will register the strength of open or closed circuit batteries.

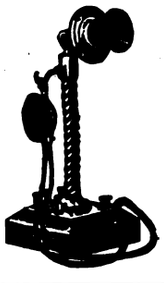
Price each, $3.50.

**Telephone Receivers.**



Hard Rubber.

$1 25 each.



**Desk Telephone Outfit, No. 11.**

Price .....$9.00.

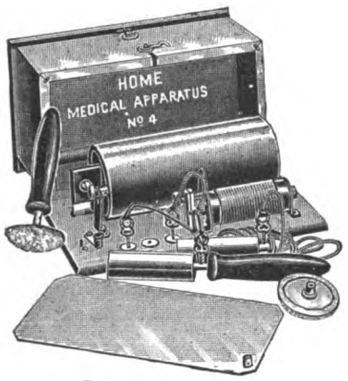
We make a dozen different Telephone Outfits.



**Telephone Outfit, No. 14.**

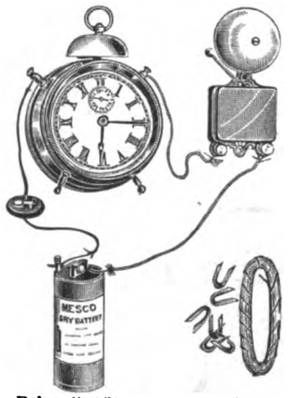
With our high grade carbon transmitter, which will be sent on approval to responsible parties.

Price with 2 cells Mesco Dry Battery, $7.50.




Price .... .....$1.50.

**Alarm Clock Outfit, No. 1½.**

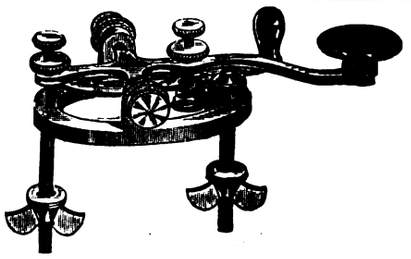



Price, Outfit.....$3.75.
" Clock only..... 2.25.

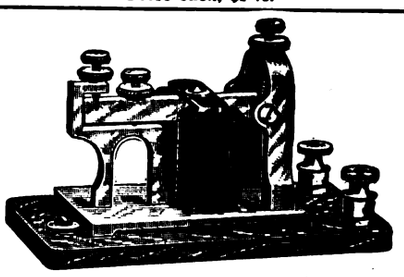
**Alarm Clock Outfit, No. 7.**



Rings until switch is turned. No oversleeping when this outfit is used.
Price.....$3.50.



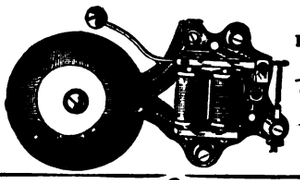
**Improved Steel Lever Key (with Legs).**
Price each, $1 75.



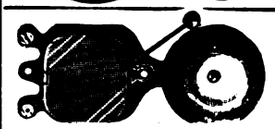
**Improved Giant Sounder.**
Aluminum or Brass Lever.
Price 5 ohms, each $2.25.
" 20 " " 2.50.

We make a full line of Telegraph Instruments.

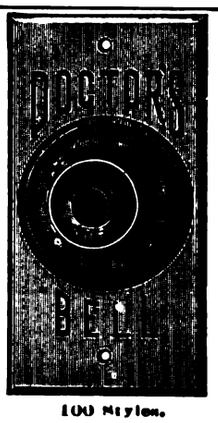
**Pivoted Armature Bells.**



Finely Finished Cast Gongs, All Sizes.



**Iron Box Bells, No. 197.**
2½, 3, 3¼ and 4 inch.
Special Prices.




**Bronze Push Buttons.**

Finely finished dark bronze.

Nickel Plated, Black Inlaid, Silver Plated, Silver Oxydized, Antique Copper, Copper Oxydized, Dead Black, Brass (Plated) and Satin.

100 Styles.

## Our Catalogue No. 11 will soon be ready.

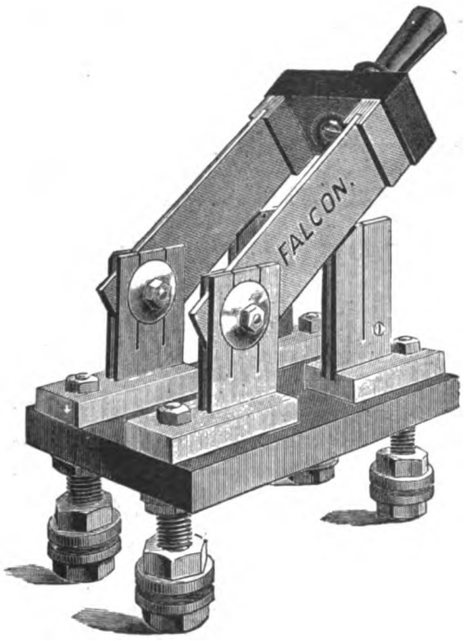
**We have purchased** the plant of the Carr Metal Company, and can furnish the Carr Zincs in all forms and quality heretofore supplied by that company.

**EVERYTHING ELECTRICAL at Reasonable Prices.**

**MANHATTAN ELECTRICAL SUPPLY CO.,** 32 CORTLANDT ST., NEW YORK.


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# The Falcon Electric Mfg. Co.




*GENERAL OFFICE AND FACTORY:*

**432 & 434 East 71st St., New York.**

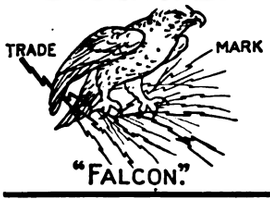
***High Grade....***

***Switches,***

***Switch-Boards***

***and Panel Boards.***

All Switches made of pure drawn copper, and in accordance with rules of the National Board.



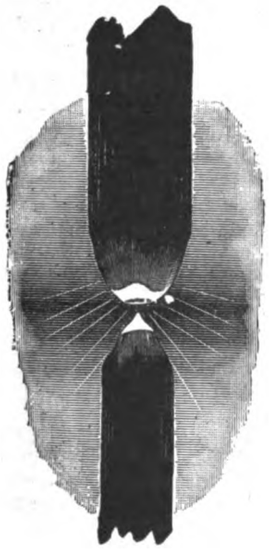

## "FALCON" FLUSH RECEPTACLES

..... THE ACME OF PERFECTION.....

ESTIMATES GIVEN ON ALL KINDS OF SWITCH AND PANEL BOARDS.
CORRESPONDENCE SOLICITED.

## ...HIGHEST GRADE...

# "SHIP" CARBONS



For Enclosed and Open Arc Lamps are unexcelled for efficiency, brilliant and steady light. If you aim for the best results, use "Ship" Carbons in your lamps.

**Write to us for Samples. We furnish them free.**

## A Full Line of Electrical Supplies

CARRIED IN STOCK.

EASTERN SELLING AGENTS FOR

**THE FALCON ELECTRIC MFG. CO.'S SWITCHES, RECEPTACLES, ETC.**

WRITE FOR PRICES.

**SCHIFF, JORDAN & CO.,** 232-234 Greenwich Street, NEW YORK.


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# WOULD NOT 2,000 VOLTS JAR YOU?

**Do you need such a shock** to make you realize the necessity of a thorough technical training in your profession? Hundreds of enterprising electricians have secured better positions after completing our comprehensive and up-to-date course in

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**YOUR SALARY** will keep pace with your efficiency and value to your employer. As your knowledge increases, so will your wages. By taking advantage of our instruction during leisure moments the Student secures a thorough education in the theoretical details of his profession, without interfering with his daily work.

Our School is **CHARTERED BY THE COMMONWEALTH OF MASSACHUSETTS**; our text-books were prepared by expert electricians, and the instruction is conducted by practical engineers, graduates of the leading technical schools. Our TERMS are so low that any wage-earner can receive the benefit of our instruction.

**SUCCESS IN THE ELECTRICAL FIELD IS IMPOSSIBLE WITHOUT TECHNICAL KNOWLEDGE.**

**WRITE IMMEDIATELY** for **"HANDBOOK A"**
describing method, courses and SPECIAL OFFER for OCTOBER.

## AMERICAN SCHOOL OF CORRESPONDENCE,

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# OUR JUNCTION BOXES



Are of Standard type for all construction work, and do not have to be made for each job.

They are the Acme of Convenience and Durability.

The finish and price are the best.

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Agent for Greater New York and New Jersey.

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Central Western Agency.

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Including Junior, Senior, Advanced Senior, Telephony, Telegraphy, Electric Railways, Electric Mining, Central Station Working, etc. Our instruction papers are prepared by the highest authorities, such as Prof. Francis B. Crocker, Columbia University, New York; Chas. F. Scott, Chief Electrician, Westinghouse Electric & Manufacturing Co., Pittsburg, Pa., and many others. Our Institute is endorsed by every prominent Electrical Engineer.

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# OUR STUDENTS SUCCEED

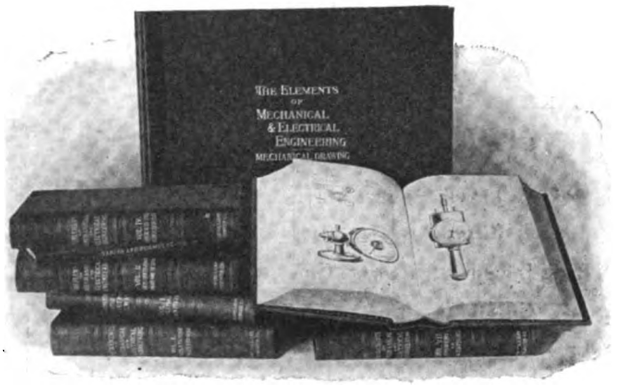
## Our Success has resulted from the Success of our Students.

In 1891, our manager, Mr. T. J. Foster, originated a system of instruction which offered its students a certain means of advancement. If the instruction had failed to advance men in their positions and increase their salaries, these wonderful Schools would not exist; but **results**, quick and sure, have developed them in nine years from an experimental undertaking to the largest and most popular educational institution in the world.

## Nine Electrical Courses.

**Electrical Engineering, Electrical, Electric Power and Lighting, Electric Lighting, Electric Railways, Telephony, Telegraphy, Electric Mining, Wiring and Bell Work.** Electrical Instruction in charge of Prof. R. B. WILLIAMSON, formerly Professor of Electricity in Lehigh University.
**112,000 STUDENTS AND GRADUATES. September, 1899. Capital, $1,500,000. $12 to $70, in Small Monthly Installments, pays for a**

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**DUPLICATE SETS OF INSTRUCTION PAPERS, BOUND IN HALF LEATHER.**

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**RAISED $70.00 A MONTH.**
When I enrolled in the Electrical Engineering Course, I was working as second engineer for The Orville Light, Heat & Power Co. Now I am General Manager and Treasurer for the same Company, increasing my salary $70.00 per month, for which I credit The Schools. I take pleasure in recommending The International Correspondence Schools to all those who are anxious to better their condition.—C. V. GILBERT, Orville, Ohio.



**ENDORSED BY PROMINENT ENGINEER.**
My advice to any person who can spare a little time each day for study is to enroll in the Schools. I can honestly recommend the system of instruction, as I have been very much benefited by it, and others whom I have helped to enroll have also derived great benefit. I am now Electrical Engineer for the S. D. Warren & Co. Paper Mills, the largest paper mills in this country.—WM. B. BRAGDON, Westbrook, Me.



**GENERAL FOREMAN BENEFITED.**
When I enrolled in the Mechanical Drawing Course, I had no knowledge whatever of the subject. Now I feel qualified to handle any line of drafting in my business. I afterwards enrolled in the Complete Mechanical Course. My studies have been of great benefit to me in my position as General Foreman of the Car Department of the Lake Shore & Michigan Southern Railway.—R. W. BURNETT, Englewood, Ill.

**A MASTER MECHANIC'S OPINION.**
I have just completed the Locomotive Engineering Course, and have enrolled in the Electrical Engineering Course. I have found the method of instruction very systematic and complete. The Instruction Papers treat the various subjects in a very exhaustive manner. I have been greatly benefited since I became a student and now have a responsible position as Master Mechanic of the Central Railroad Co. of New Jersey.—J. S. CHAMBERS, Elizabethport, N. J.



**SUBSTANTIAL INCREASE IN SALARY.**
I can recommend The International Correspondence Schools with pleasure. I enrolled in the Electric Power and Lighting Course, November 30th, 1897, and through the commendation of The Schools I secured a position as Electrical Engineer for the Blakely Light Plant, Peckville, Pa., at a substantial increase in salary.—EDGAR M. BARNES, Peckville, Pa.



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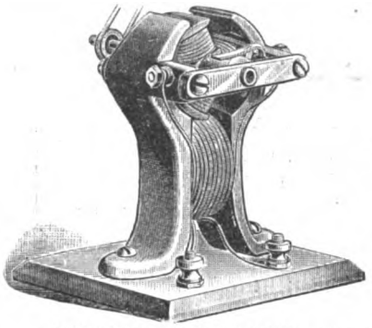
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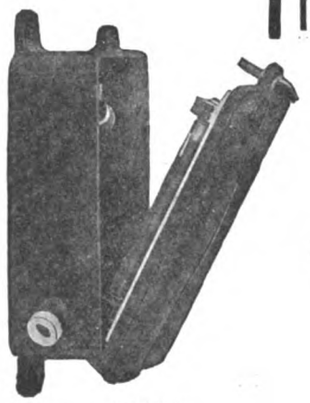
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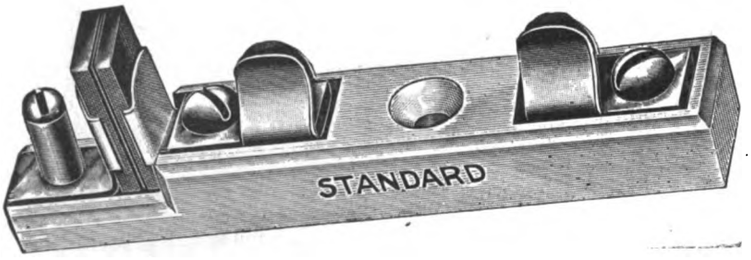
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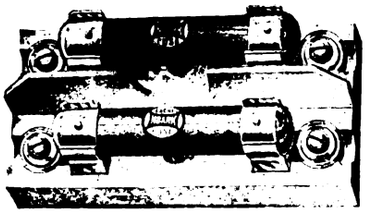
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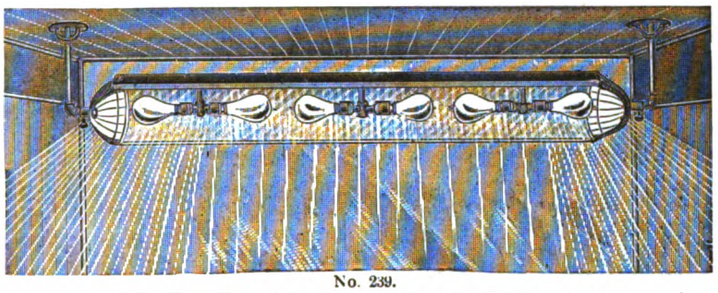
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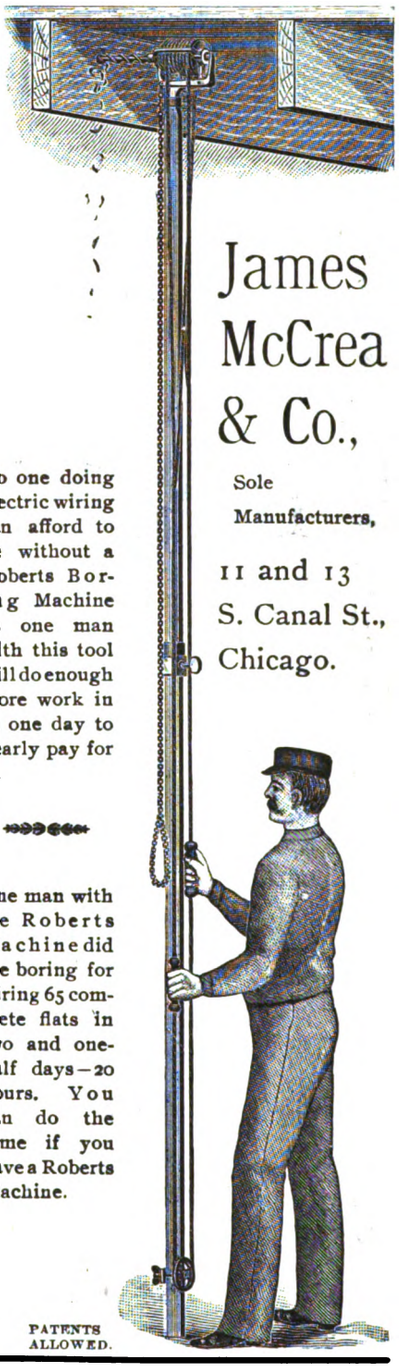
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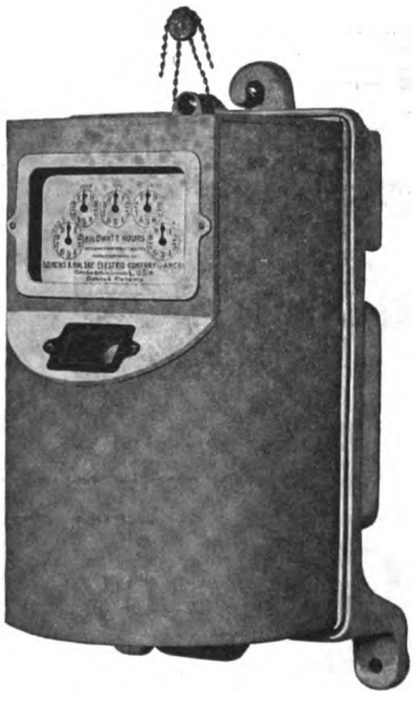

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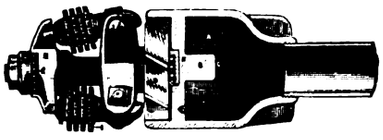
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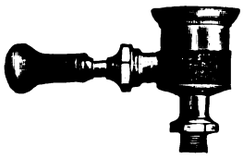



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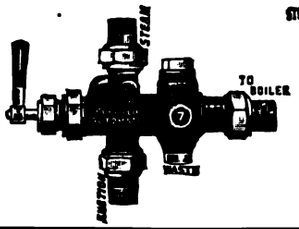


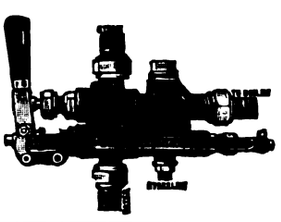
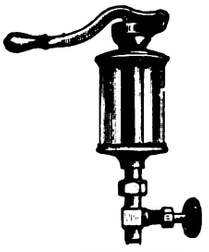
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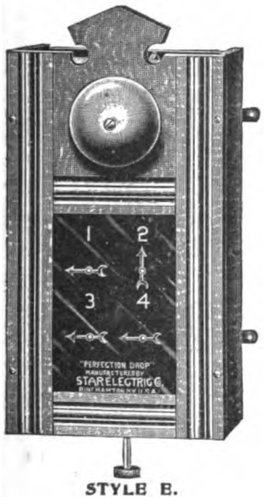




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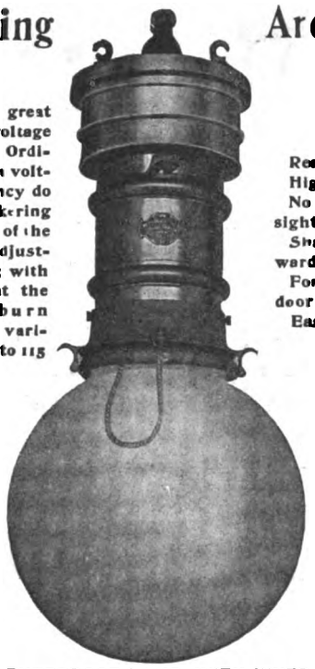
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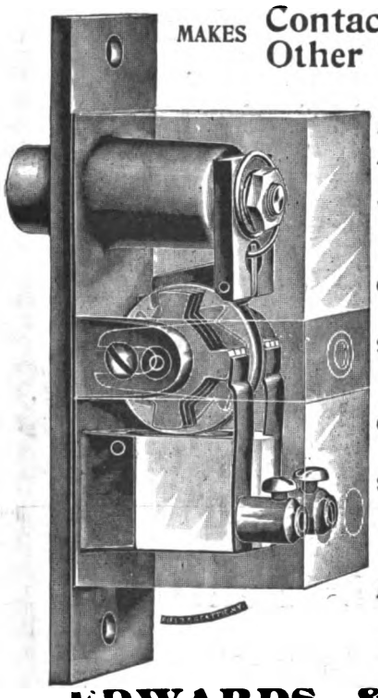
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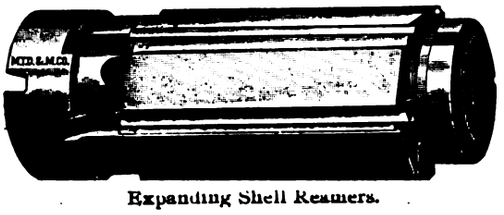
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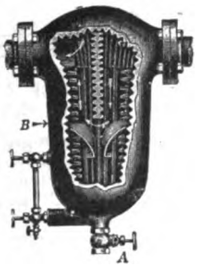
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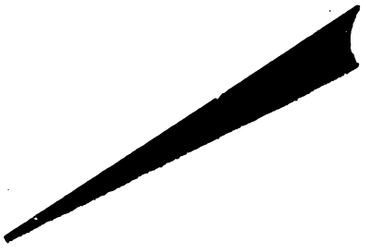


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| 1 D 50 125-volt T. H. | 1 Chandler-Taylor, 11x 12. | 1 60 K. W. G. E. Alternator, 2080-volt. | 1 West 250 K. W., 500-volt | 10—40 Light Stanley 1,000-50 100.20.00 each |
| 1 35-H.P. 220-volt Sprague Motor. | 2 Straightline, 10x16. | 2 60 K. W. Slattery Alternators, 1040-volt. | 1 Brush 175 K. W., 500-volt Ry. Motors. | 10—50 Light Stanley 1,000-50 100.25.00 each |
| 1 60 K. W. 500-volt Edison Dynamo. | 1 Taylor-Beck, 11x12. | 2 300 K. W. G. E. Alternators, 1040-volt. | 10 W. P. 50. | 3—75 Light Stanley 1,000-50 100.37.50 each |
| 1 100 K. W. 220-volt Elwell-Parker Shunt Dynamo, 500 Rev. | 1 Erie Ball, 12x12. | 1 70 K.W. A-70 Alternator, 1040-v. | 10 W. P. 30. | 5—100 Light Stanley 1,000-50 100.52.50 each |
| | 1 Erie Ball, 16x16. | 1 60 K. W. Warren Alternator, 1040-volt. | 8 Walker. | 9—6 Light T.H. F. 1,000-50 100. 6.00 each |
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## T-H ARC GENERATORS.

| MACHINE. | DESCRIPTION. | LOCATION. | PRICE. | MACHINE. | DESCRIPTION. | LOCATION. | PRICE. |
|---|---|---|---|---|---|---|---|
| One L-2 T-H arc generator, No. 169. | Good operating condition. Has oil cup bearings, regulator, controller and base frame. | Lynn | $275 | One LD-12 T-H arc generator, No. 1891, solid core armature. | Good operating condition. Has oil cup bearings, regulator and controller. | Lynn | $325 |
| One E-2 T-H arc generator, solid core armature. | Good operating condition. Has oil cup bearings. | Chicago. | 100 | Two LD-12 T-H arc generators, ring armatures. | Good operating condition. Have oil cup bearings, regulators and controllers. | Lynn. | 400 Each. |
| One E-12 T-H arc generator, solid core armature. | Good operating condition. | San Francisco. | 150 | | | | |
| Three M-12 T-H arc generators, Nos. 851, 928 and 1035, solid core armatures. | First class second-hand condition. Have regulators, controllers, base frames, oil cup bearings and pulleys 15" x 8". | Lynn. | 280 Each. | Two LD-12 T-H arc generators, Nos. 2750 and 3468 ring armatures. | First class second-hand condition. Have oil cup bearings. | Chicago. | 300 Each. |
| Two MD-2-45 light, T-H arc generators, ring armatures. | Good operating condition. Have oil cup bearings, base frames, regulators and pulleys. | Lynn. | 400 Each. | Two LD-12 T-H arc generators, ring armatures. | First class second-hand condition. Have base frames, regulators, pulleys, controllers and oil cup bearings. | Schenectady. | 400 Each. |
| One L-12 T-H arc generator, No. 397. | Good second-hand condition. | Harrison. | 260 | One MD-2 T-H arc generator. | Good operating condition. Has base frame regulator and controller. | Atlanta. | 400 |
| Six M-12 T-H arc generators, Nos. 3977, 2176, 2151, 1026, 1494 and 877, solid core armatures. | Good operating condition. Have oil cup bearings, regulators and controllers. | Lynn. | 275 Each. | Two MD T-H arc generators, Nos. 4047 and 4064, ring armatures. | Good second-hand condition, self-oiling bearings with regulators and controllers. | Denver. | 300 Each. |

## BRUSH ARC GENERATORS.

| MACHINE. | DESCRIPTION. | LOCATION. | PRICE. | MACHINE. | DESCRIPTION. | LOCATION. | PRICE. |
|---|---|---|---|---|---|---|---|
| Four No. 7 1200 c.p. Brush arc generators. | Good operating condition. Have oil cup bearings. | Lynn. | $300 Each. | One No. 7 1200 c.p. Brush arc generator. | First class second-hand condition. | Chicago. | $150 |
| One No. 7½ 2000 c.p. Brush arc generator, No. 131. | Good operating condition. Has oil cup bearings. | Lynn. | 500 | One No. 11 2000 c.p. Brush arc generator. Available Nov. 1, '99. | First class second-hand condition. In use only 5 months. Has oil regulator multi-circuit. | Chicago. (Omaha). | 2000 |

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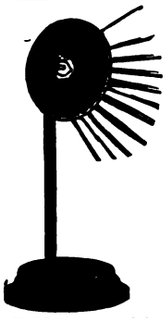
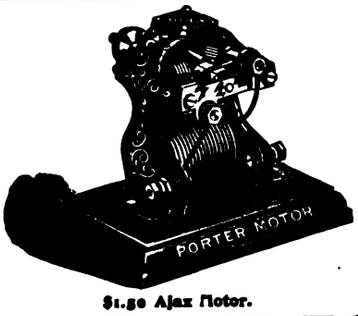


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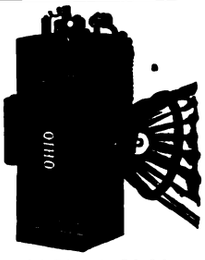

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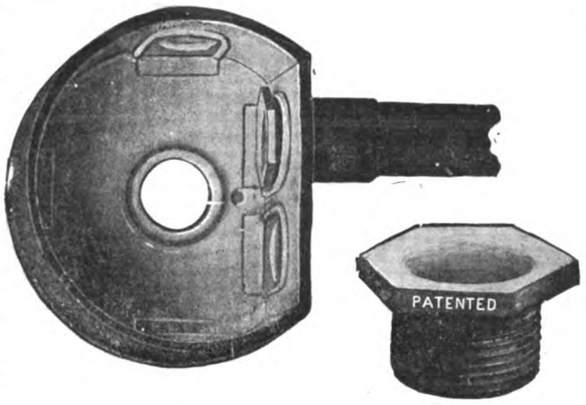

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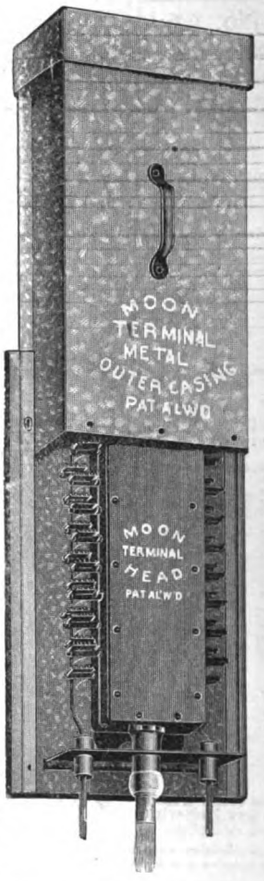
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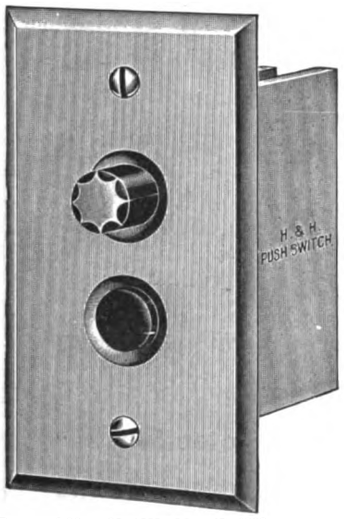
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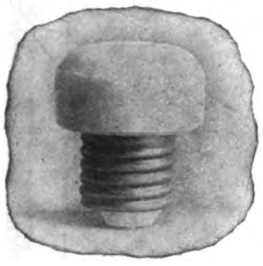
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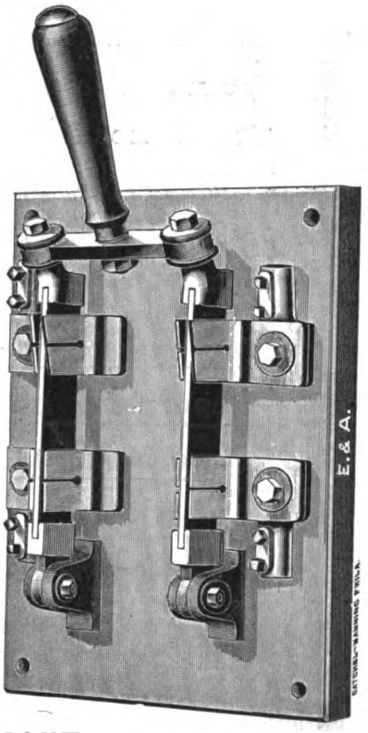
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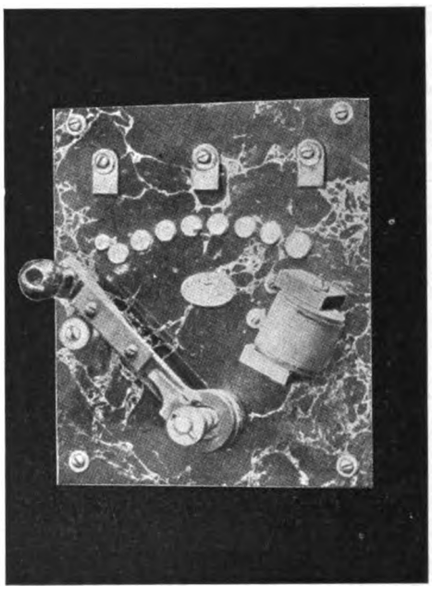

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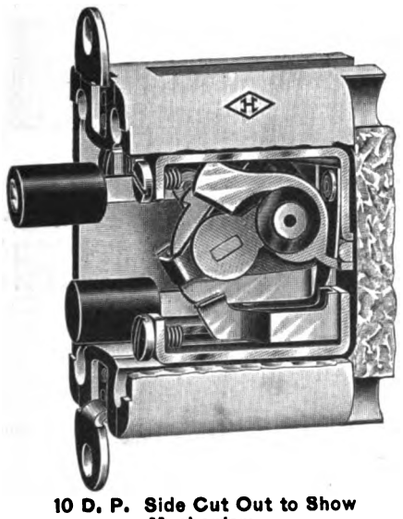
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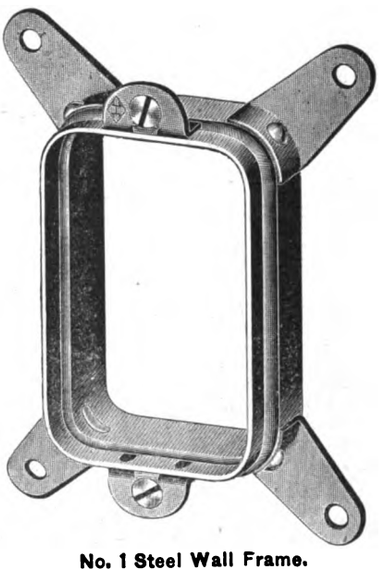
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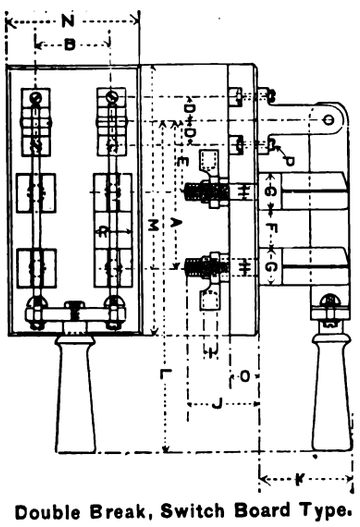
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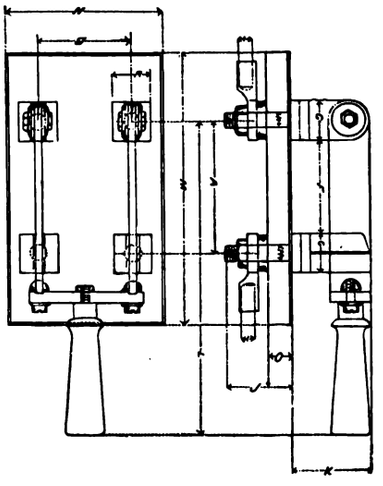
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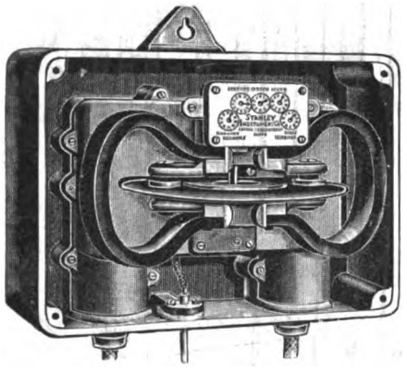
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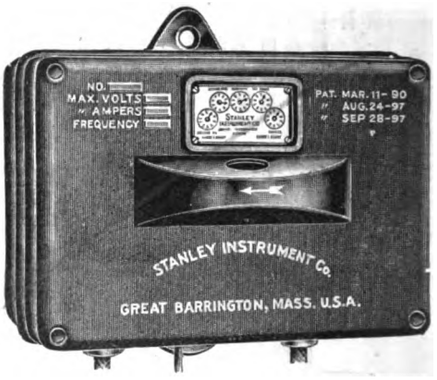
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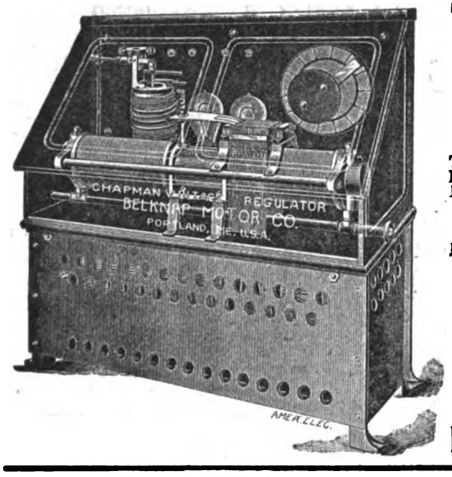
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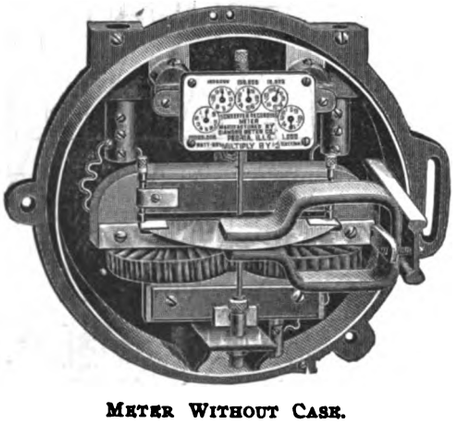
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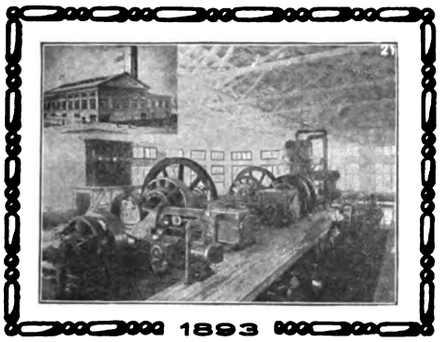

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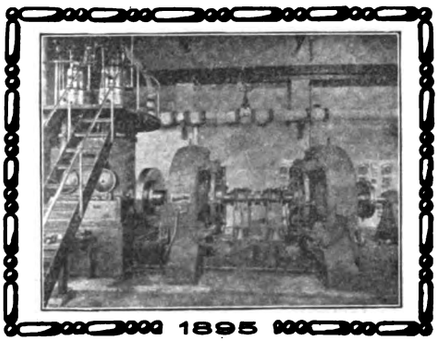
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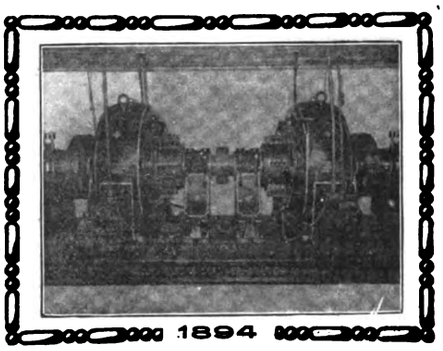
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The **FIRST** successful elevated electric road in the United States.


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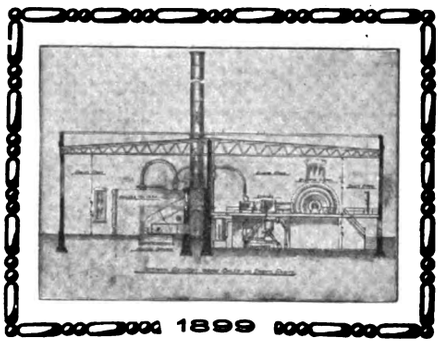
THIS COMPANY DESIGNED AND BUILT


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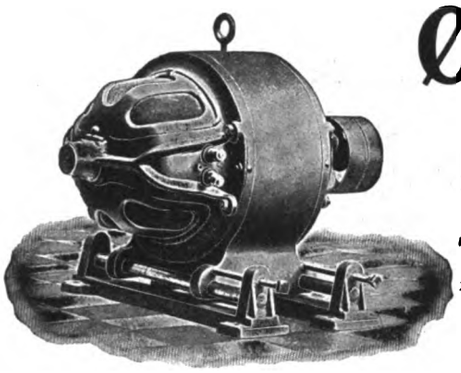
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**This company is prepared to submit propositions on complete electric plants for any purpose, under reliable guarantees, after learning particulars.**

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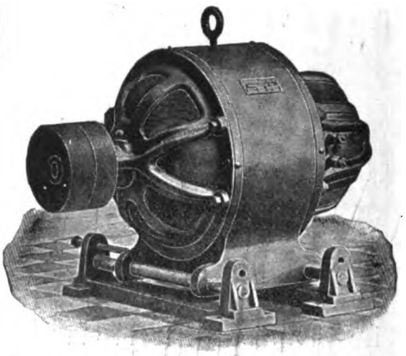
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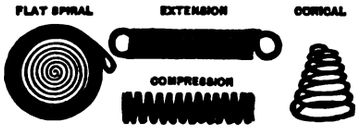


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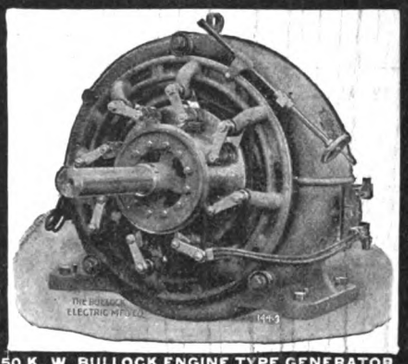
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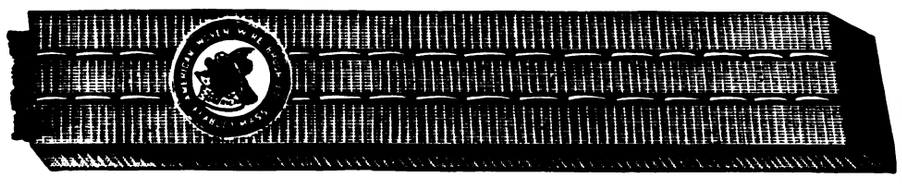
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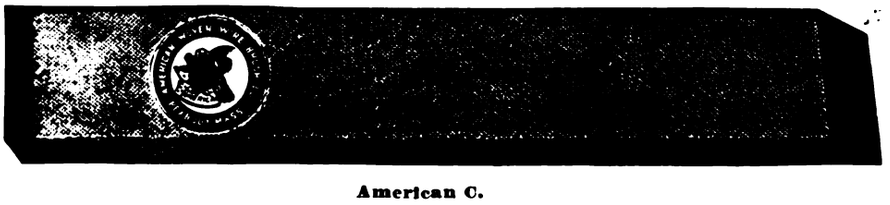
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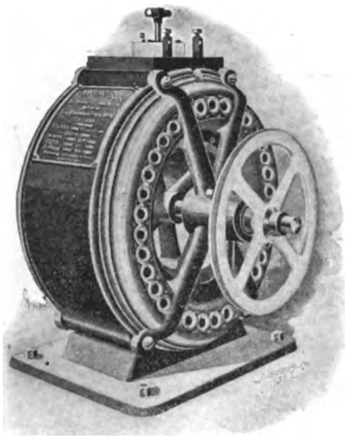
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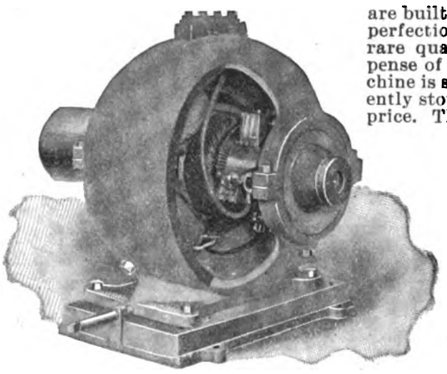
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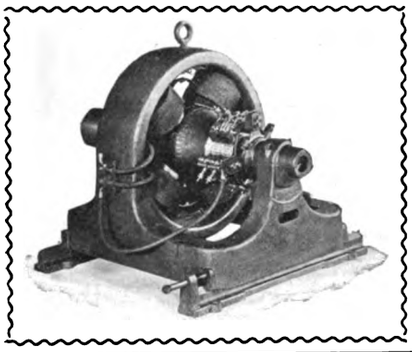


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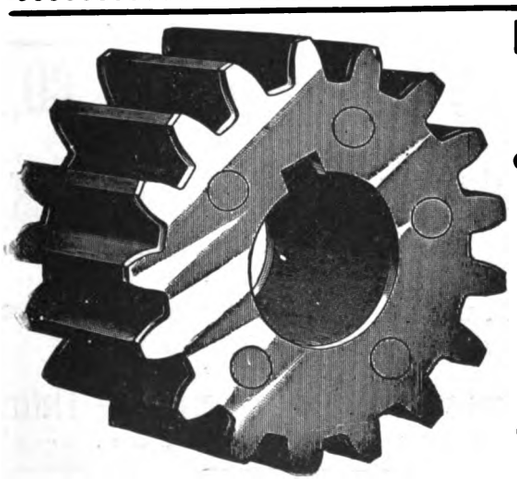



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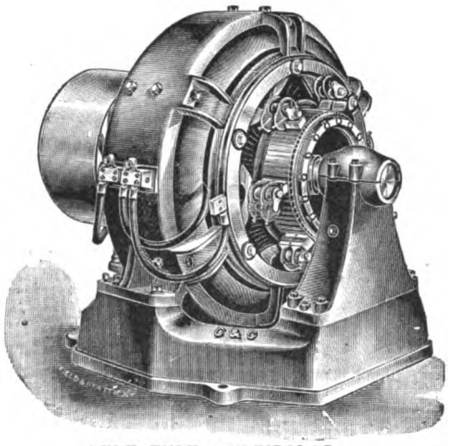
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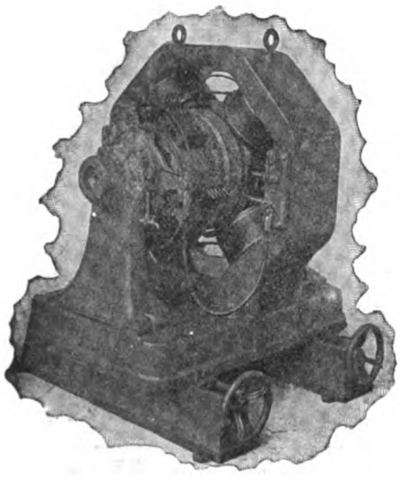
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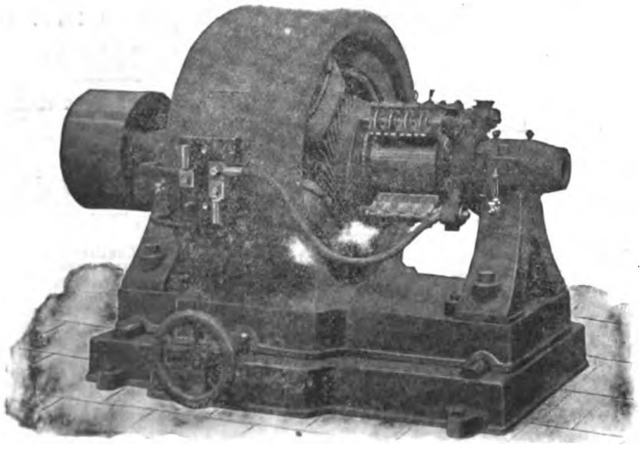
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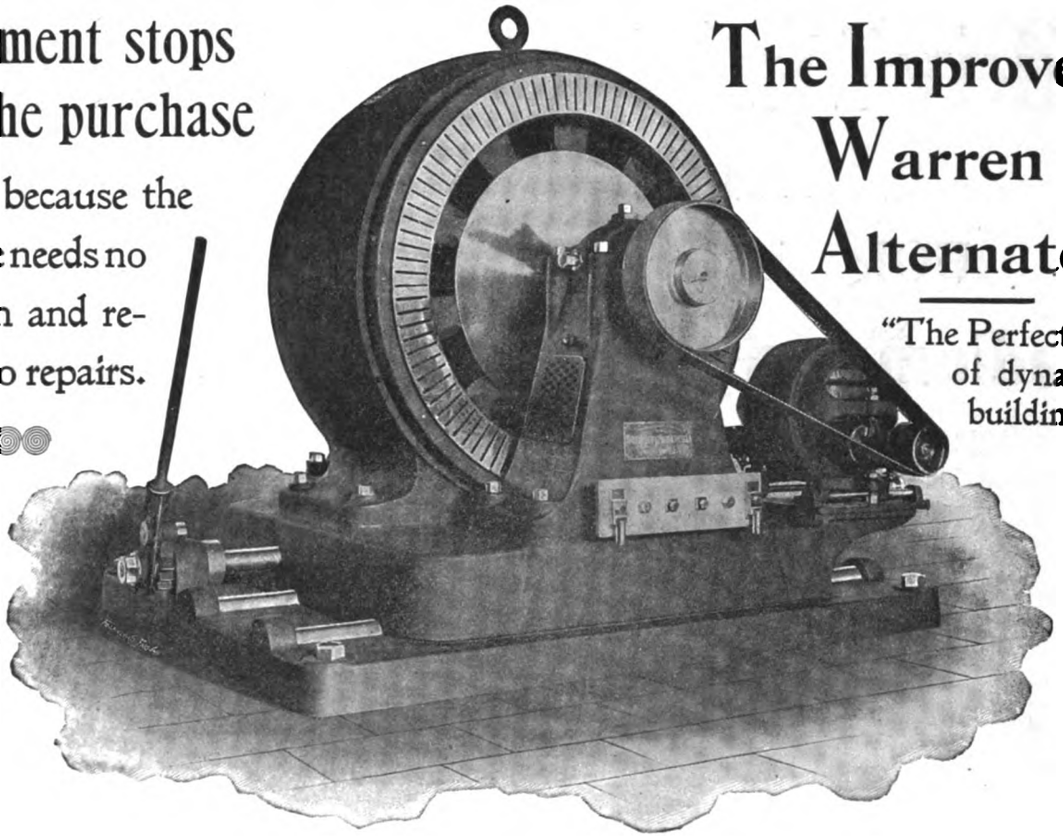

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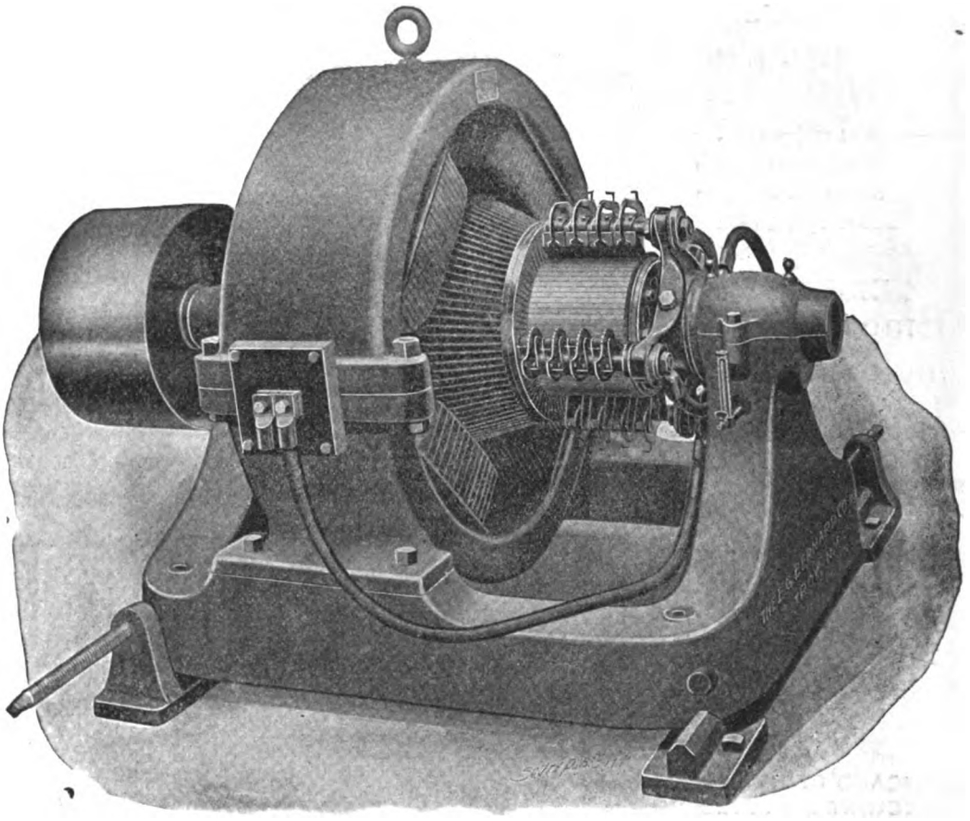
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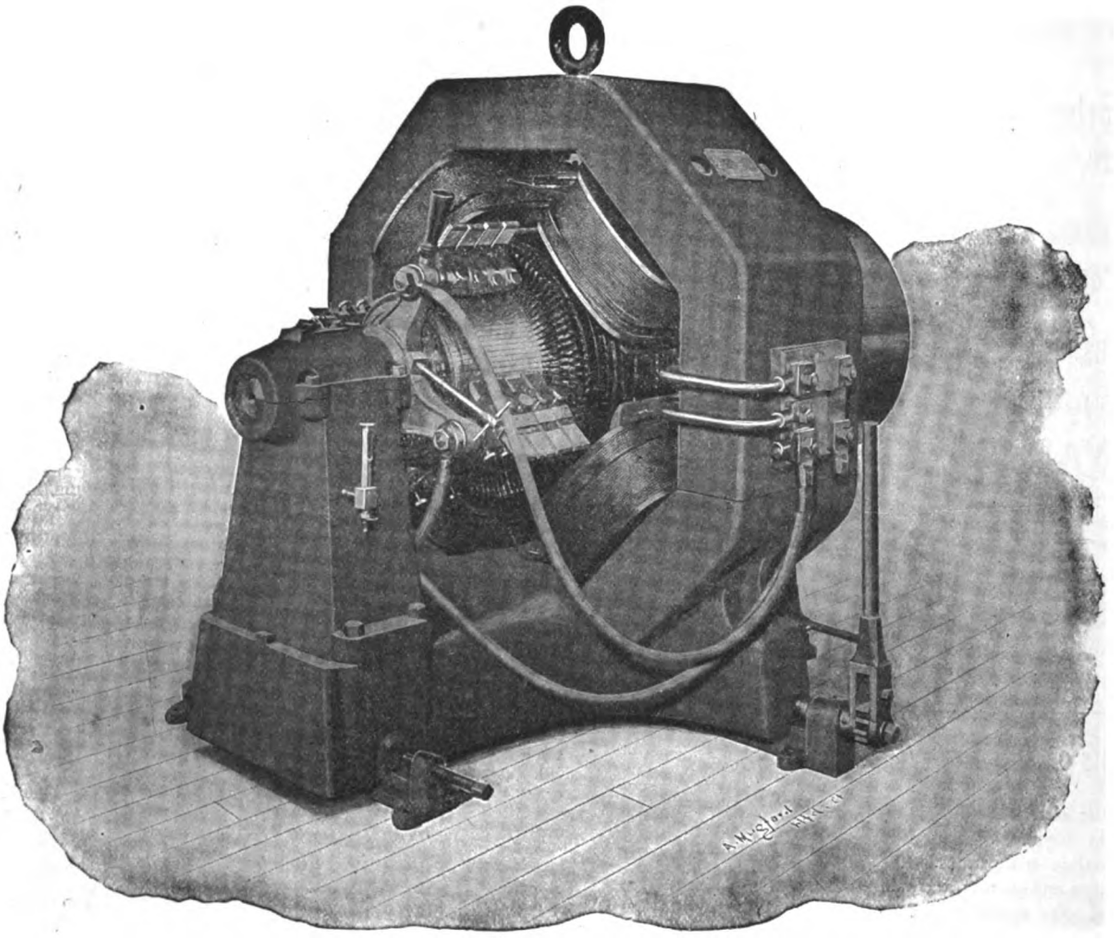

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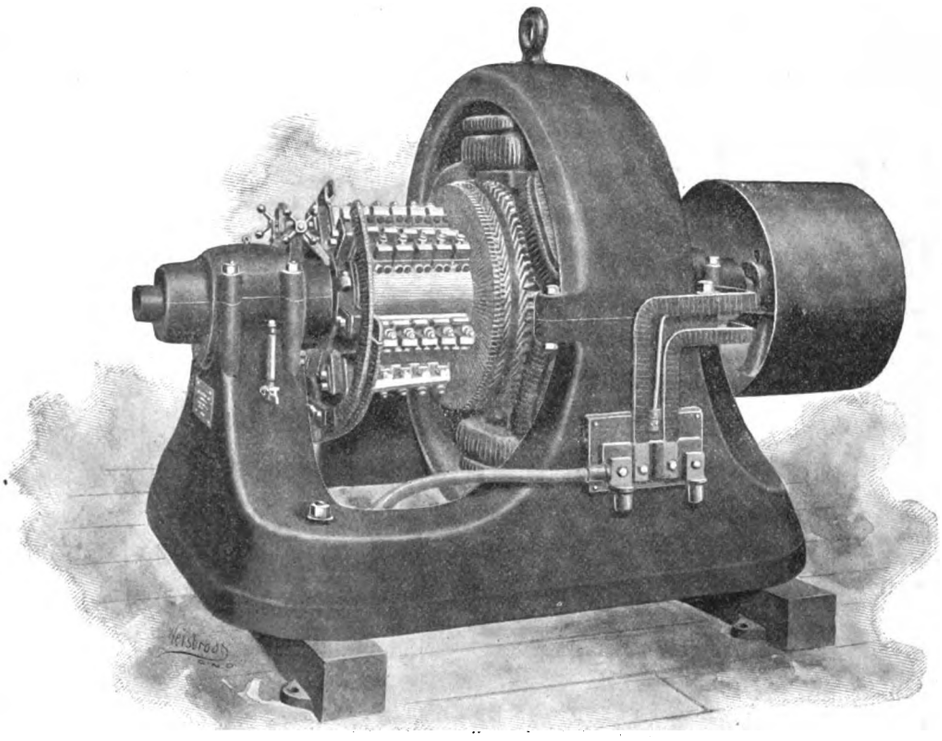
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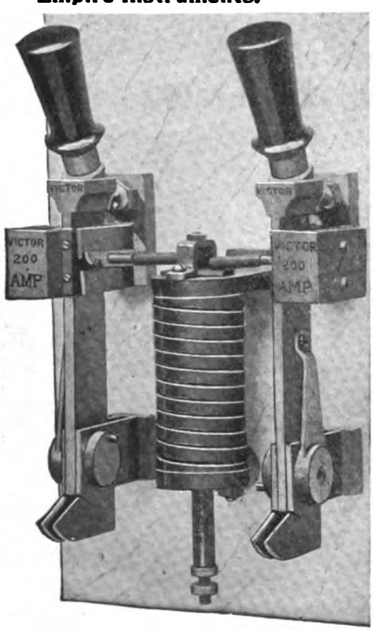
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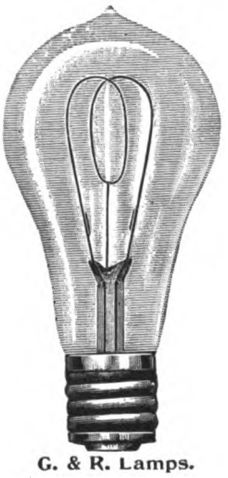
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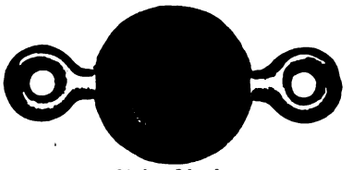
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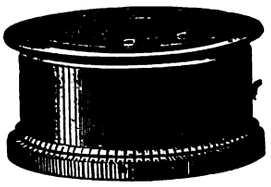
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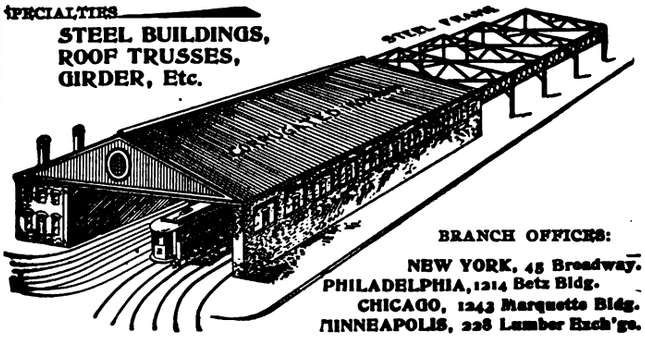
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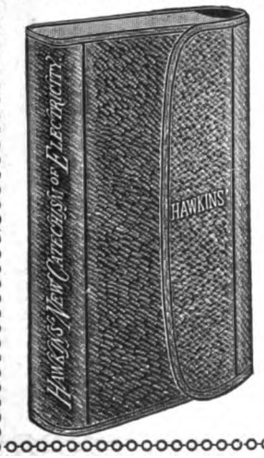
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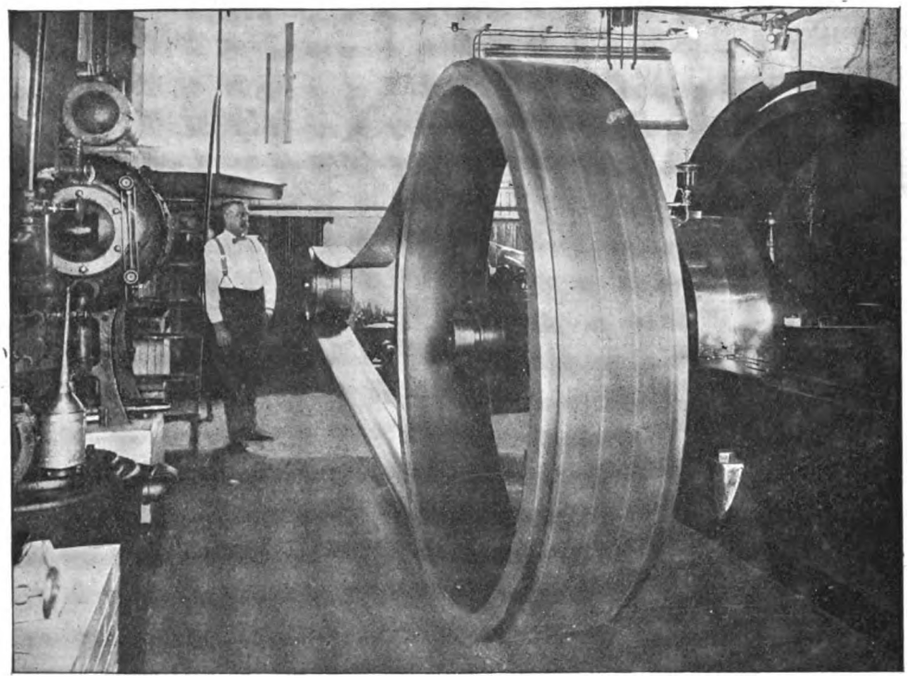
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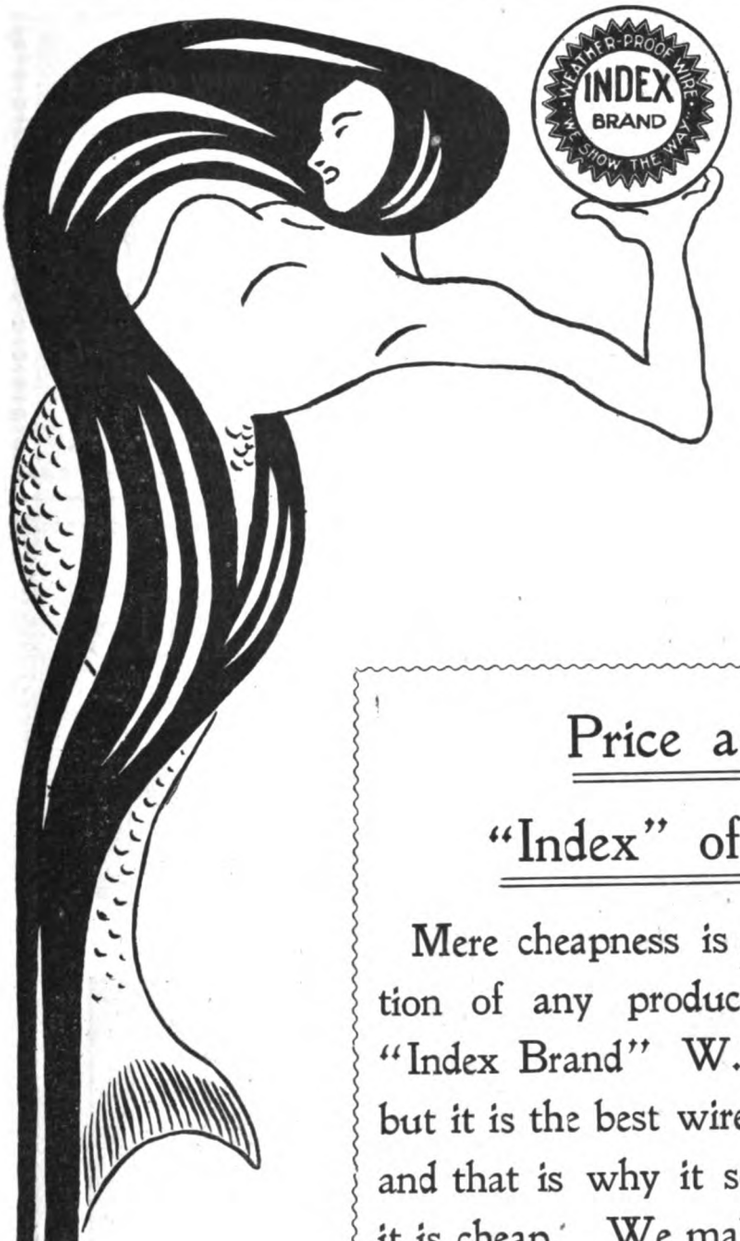
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H. B. PRESCOTT, Engineer.

Four months ago this belt was as tight as a fiddle string, under about 1,000 lbs. initial tension, and yet was slipping.

There is no slip now, for it runs slack. **Cling-Surface** did it.

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Mere cheapness is no recommendation of any product. We sell our "Index Brand" W. P. Wire cheap, but it is the best wire in the market, and that is why it sells—not because it is cheap. We make the price low, though, as we are absolutely independent of all "Combinations." When you buy our goods you pay for the goods and nothing else.

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FOR TELEPHONE EXCHANGES.

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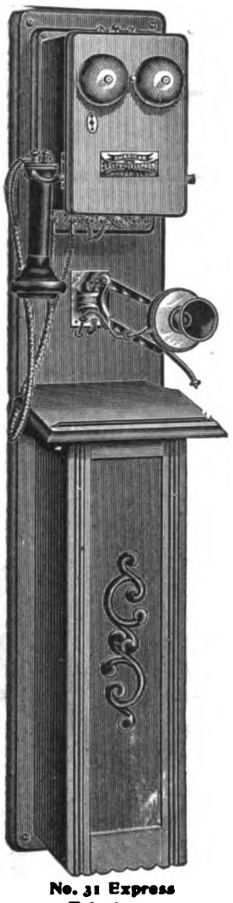
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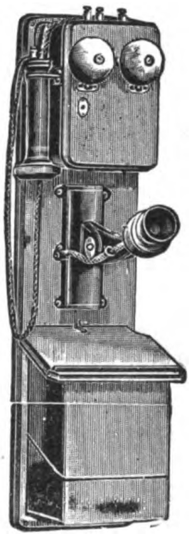


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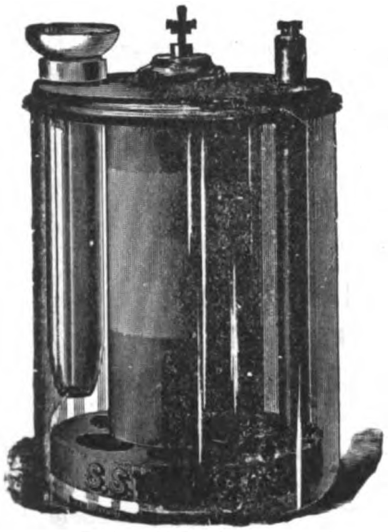
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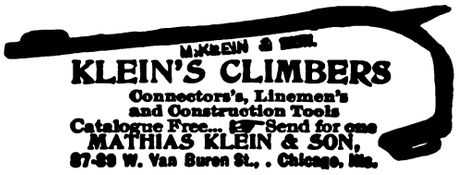


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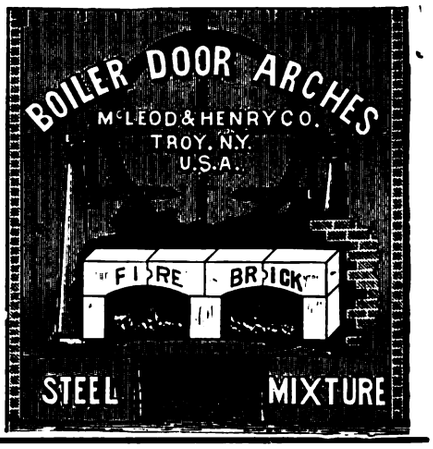
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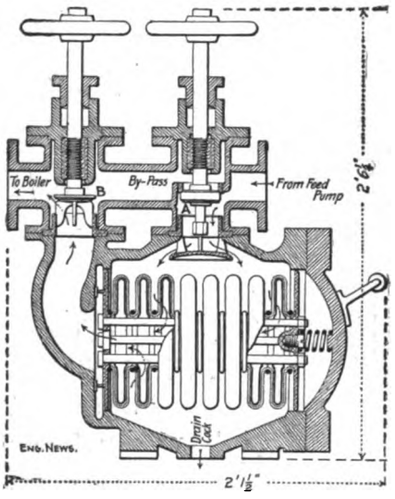
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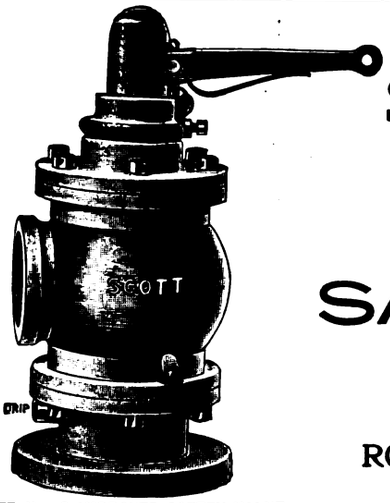
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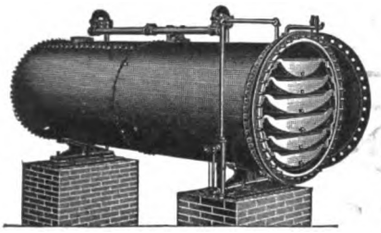
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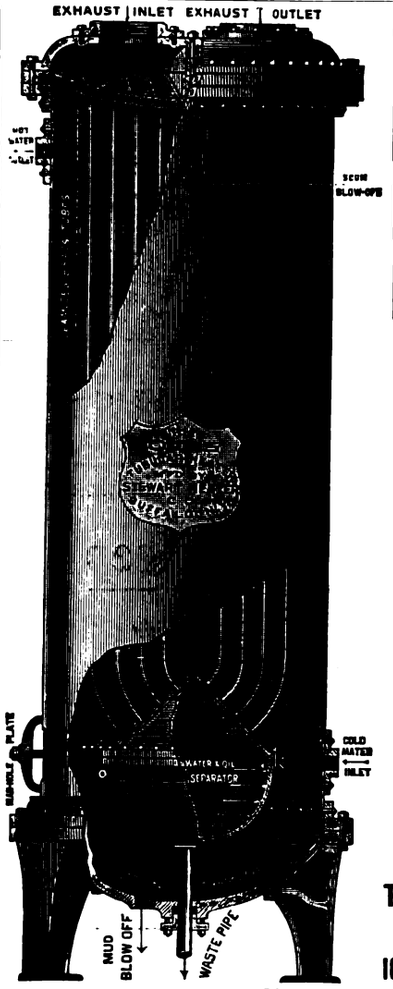
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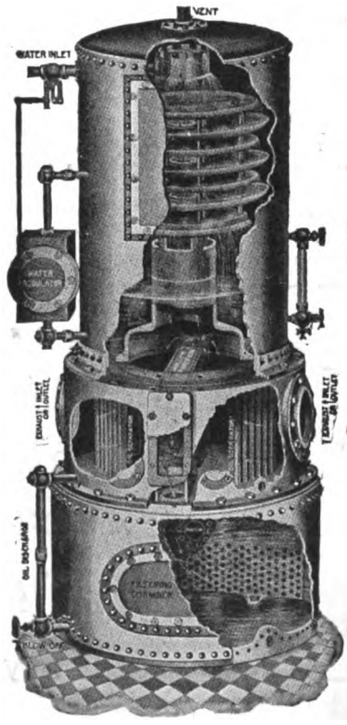

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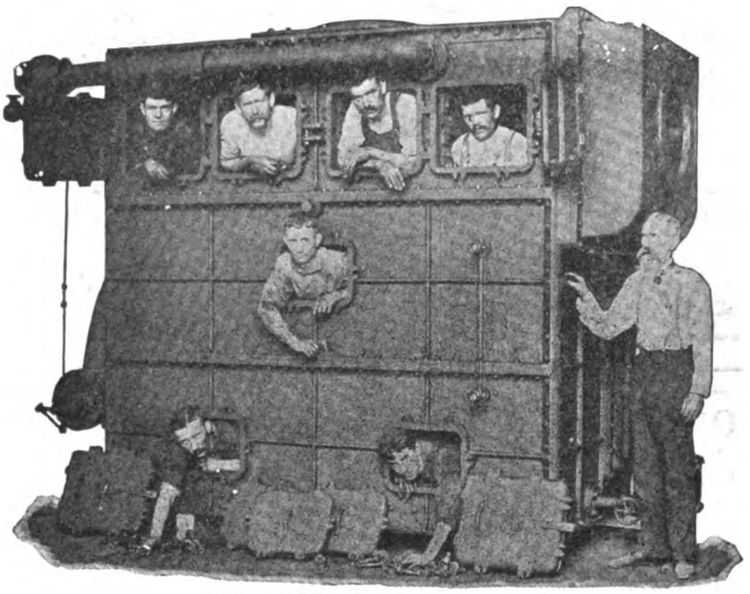
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It is not only cleaning doors and large capacity which commend these "COCHRANES" to the steam user —all the other points have received the most careful consideration. May we tell you about them?

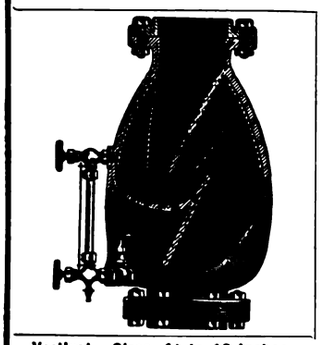
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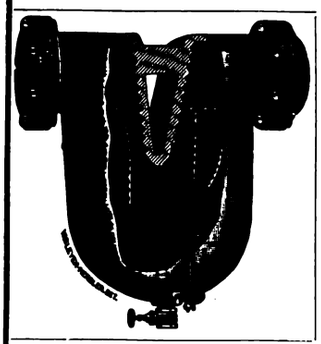
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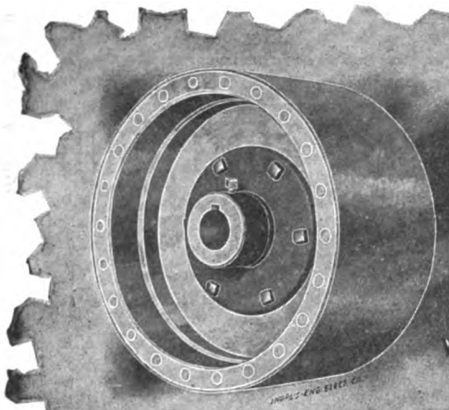
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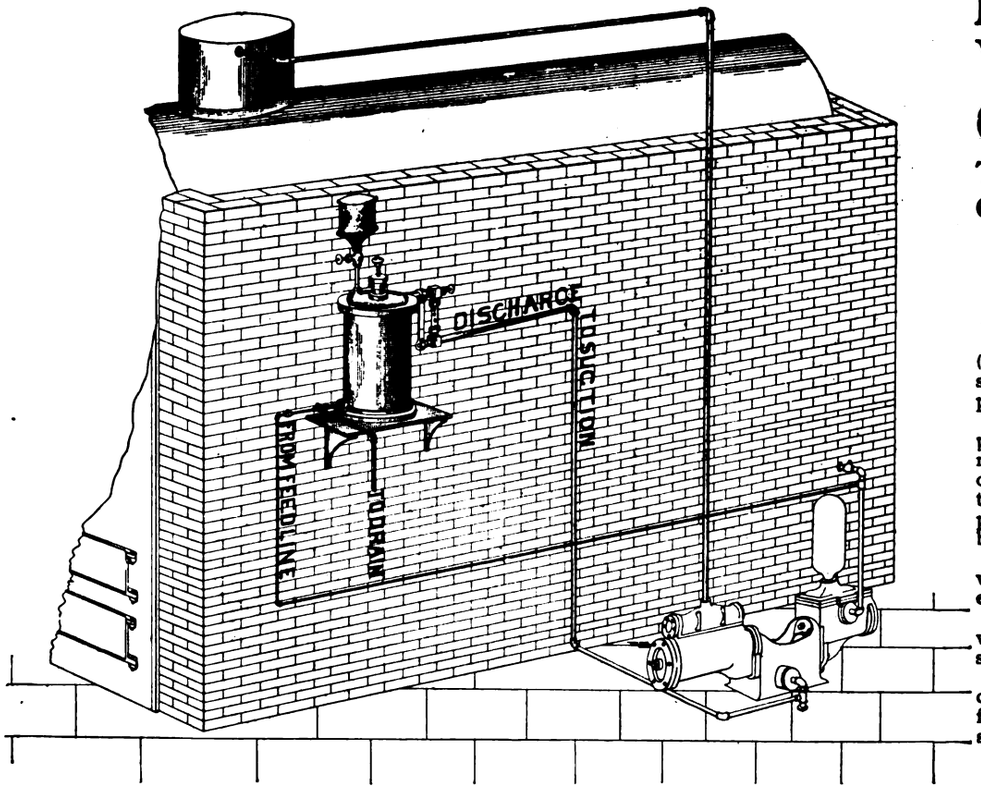
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If you use Compound (and if you do not you should) we can show you a proper way to feed it.

If water requires Compound at any time, then it requires it all the time, and our device is so arranged that every gallon of water passed through it into your boilers has been treated.

Our Feeder is to a boiler what a lubricator is to an engine.

Our Feeder will do the work for each source of supply.

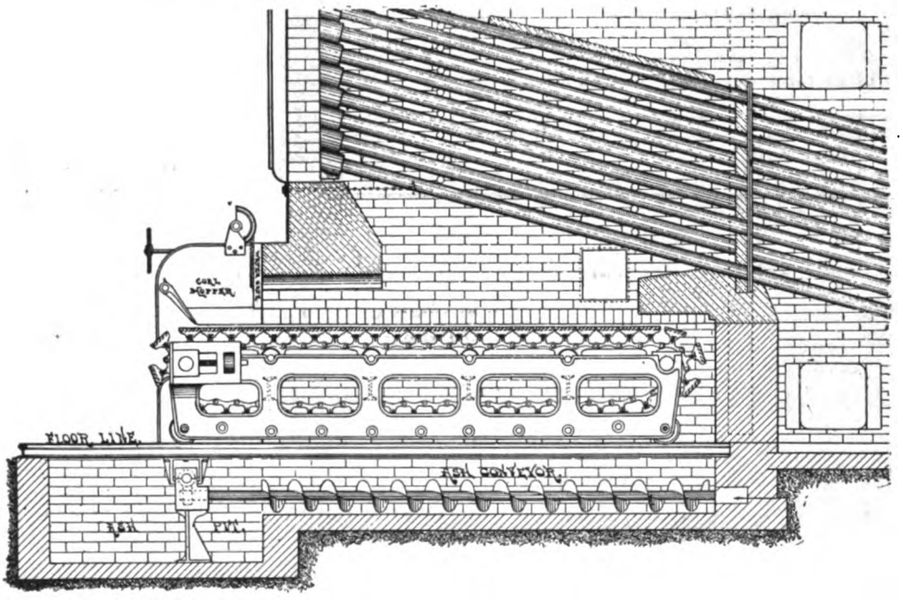
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With this machine an absolutely even thickness of coal is maintained on the grate, thereby insuring an economical fire. And by the traveling grate no clinkers can accumulate in the fire box, the grate automatically cleaning itself constantly.

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**258 Dearborn Street, Chicago, Ill.**

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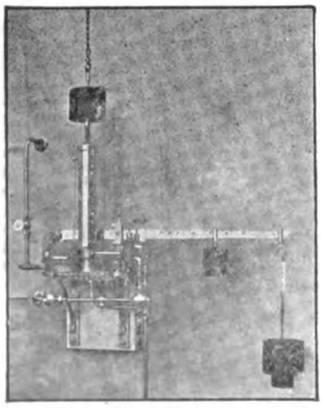


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For.... { Ordinary, Medium, Extra Heavy } Service.
And will be pleased to send their Catalogue W and prices on application.

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Designed from a Scientific and Engineering Standpoint. . . . . .

A great Fuel and Labor Saving Apparatus. Will hold the heaviest Dampers partially open. . . .

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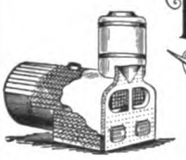
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# Improved Scraping Tools



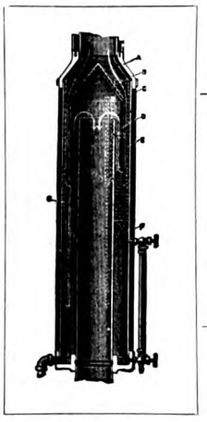

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***No Engine Room Complete without these Tools.***

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| Set of 6 Scraping Tools (Oak Case) | $2.50 |
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Mail orders promptly attended to.
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STEAM, OIL and AMMONIA.
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## HIGH-PRESSURE WATER-TUBE BOILERS.

EQUIPPED WITH

**SQUARE FURNACE, SQUARE GRATE SURFACE, STEEL JACKET LINED WITH BRICK.**

## Single Boilers or Compact Batteries.

GREAT SAVING OF FUEL AND FLOOR SPACE,

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THE BABCOCK & WILCOX CO.

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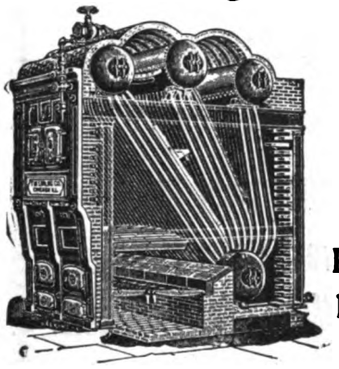
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THE BABCOCK & WILCOX COMPANY

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# *Safety Water Tube Boilers.*



OVER 350,000 H. P. IN USE.

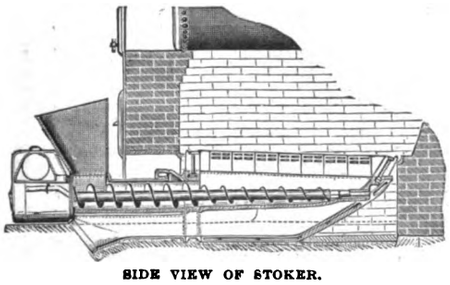
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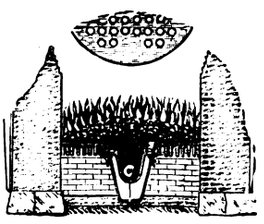
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The fact that our Stoker has no mechanical parts in contact with the fire distinguishes it from all other forms of Stokers and insures a low cost of maintenance. As our system is not dependent upon natural draft, it is especially adapted to meet the requirements of a variable power demand.

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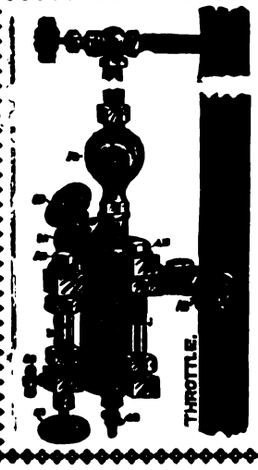
# One of the Oldest and Most Common Remedies for Boiler Scale is Kerosene.

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**Chemists and Engineers.** PITTSBURGH, PA.

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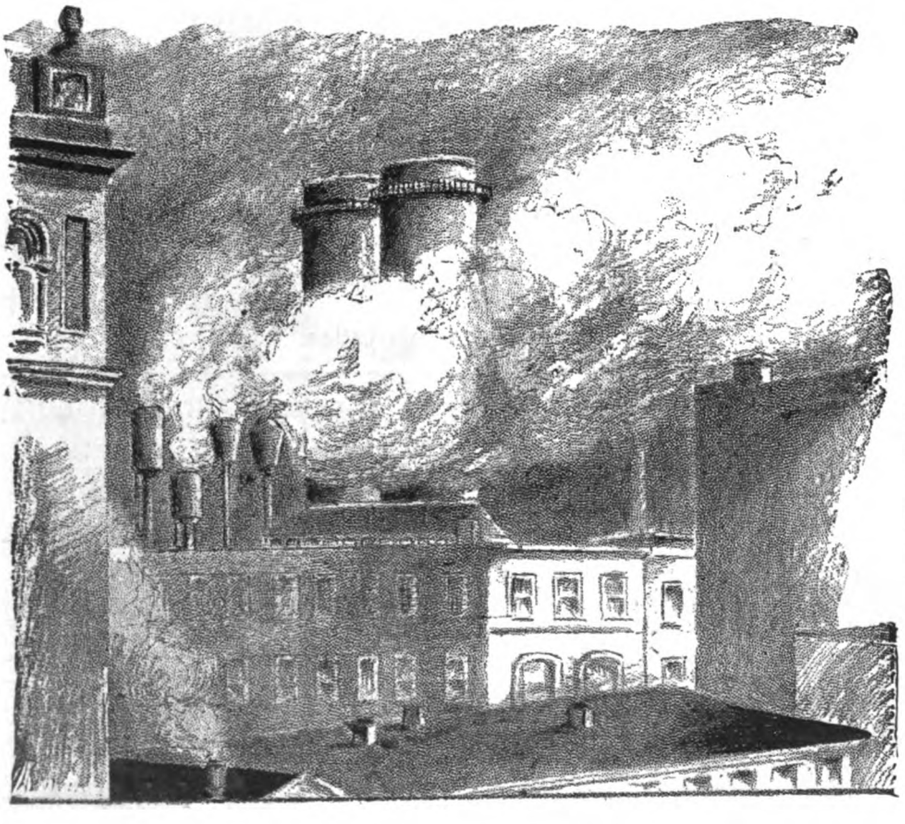

# The Detroit Lubricators in Good Company.

Fully nine-tenths of the prominent American engine builders use **The Detroit Lubricators** on their engines. They will not equip an expensive engine with an inferior or mediocre lubricator, as their experience has taught that the risk is too great. This preference by those best qualified to judge of their merits is the best recommendation that could be given to our goods. Another good recommendation is the constantly increasing demand we are having for them. We are now sending out over **5,500 Detroit Lubricators** per month, and have to increase our facilities to keep up with the demand.

**Our Catalogue showing our different Lubricators, Glass and Brass Oilers, Oil Pumps, etc., will be sent on application.**

**DETROIT LUBRICATOR CO., - - - Detroit, Mich.**

# *"Riches Taking Unto Themselves Wings."*



**A REALIZATION from ACTUAL LIFE.**

## Electric Light Plants.
## Street Railway Plants.
## Manufacturing Plants.

THE fuel bill is the great item of expense at Power Stations; 15 per cent. is utilized, 85 per cent. becomes a by-product. Do the Gas Companies and the Oil Refiners squander their by-products? If they did how long would they keep out of the receiver's hands? Every 100 H. P. of exhaust steam will heat 1,000,000 cubic feet of space in stores, churches, dwellings, offices, etc., and will sell for $2,500 to $3,500. The income thus secured will pay fuel bills at the Power Station for the entire year. This is not a guess, for it is being done by many concerns who are using the Holly System.

Mr. Manager, are you doing your duty when you sit idly by and see your stockholders robbed? It is their property and you are seeing it dissipated. Learn a lesson in true economy by sending for our catalogue.

**AMERICAN DISTRICT STEAM CO.**
**LOCKPORT, N. Y.**


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# Murphy Automatic Smokeless Furnace

THE ONLY FULLY AUTOMATIC FURNACE

## SUPERIOR RESULTS ON ALL POINTS

## SMOKE PREVENTION AND PROFIT.

### THE BEST SMOKE PREVENTION AND THE BEST ECONOMY GO TOGETHER

A smoking chimney, in connection with a large, fine building or manufactory, is an offence to the public and a constant useless waste to those who pay the fuel bills, and, in the light of known facts of to-day, it is a reflection on those responsible.

Any boiler plant equipped with an "up-to-date" furnace will burn the "steam" grade of soft coal without smoke and with decided extra profit to the owner, or whoever pays the fuel bill.

There are scores of plants in various localities where

PROFITABLE SMOKE PREVENTION

has been and is being daily demonstrated by use of the

MURPHY AUTOMATIC SMOKELESS FURNACE.

No matter what form of the common or of the so-called "improved" or "patent" furnace you now have, the Murphy will give you increased economy, better **smoke prevention** and better service in general.

Do you doubt it? Let us have opportunity and we will prove it in your boiler room.

*BRANCH OFFICES:*
*Chicago, Ill., Bedford Building.*
*Cincinnati, O., Neave Bldg.*
*Pittsburg, Pa., Lewis Block.*
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*MURPHY IRON WORKS*
*DETROIT, MICH.*

P. S.—We wish to call the attention of those who are using our older forms of construction to the fact of recent improvements, which can be applied to all our furnaces, making the furnace more completely self-cleaning and more durable and satisfactory than ever.


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Good Draft
Is essential to success with any boiler plant.

Better Draft
Can be produced by a fan at less first cost and running expense than by a chimney.

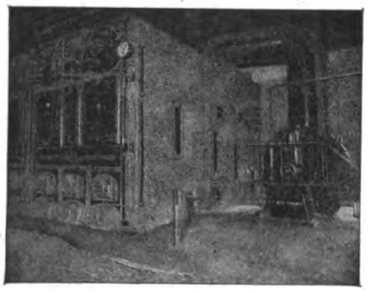
Best Draft
is, therefore,
Mechanical Draft
by which these results can be secured.

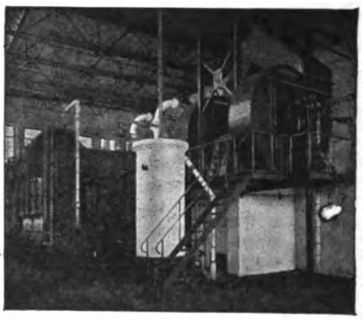
This is the size of the chimney and This is the size of the fan required for the same boiler capacity.
COMMENT IS UNNECESSARY.

# Mechanical Draft

What it is ...and What it Does.

It is draft mechanically produced by means of a fan, and may be introduced either as forced draft, by which the air under pressure is delivered to the ash pits, or as induced draft, arranged to draw the gases through the fan and to maintain a partial vacuum within the furnace. The method to be adopted must of necessity depend upon the existing conditions.





It does what an ordinary chimney is incapable of doing. Its cost is from 20 to 40 per cent. of that of a chimney; its intensity permits of the burning of finely divided or low grade fuel; it makes possible the utilization of the heat of the flue gases which a chimney wastes in producing draft; it is independent of the weather; is automatically regulated to maintain constant steam pressure, prevents smoke, increases the capacity of an existing plant, and serves as an auxiliary to a chimney already overburdened; it saves space and is portable.

Send for our Treatise on this subject. Plans and estimates cheerfully furnished.

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WAREROOMS:
BOSTON, 34 Oliver St.; NEW YORK, 131 Liberty St.; PHILADELPHIA, 135 N. Third St.;
CHICAGO, 16 S. Canal St.; LONDON, ENG., 75 Queen Victoria St.

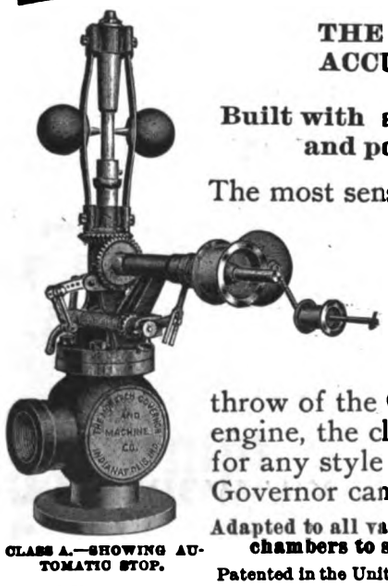
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# THE MONARCH GOVERNOR

**THE ONLY GOVERNOR ON EARTH THAT WILL ACCURATELY REGULATE ANY TYPE OF ENGINE.**

**Built with automatic safety stop, speed adjuster and valve lever, and possesses all the elements of a first-class Governor.**

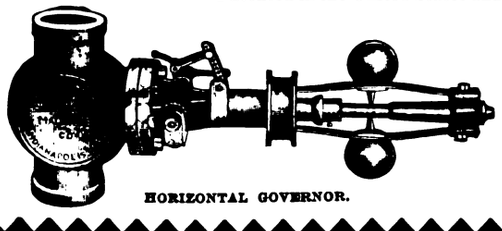
The most sensitive and the quickest acting Governor made in the world.
Neat in design, first-class in workmanship and material.
Accurately fitted to gauges and all parts interchangeable.
The valve throw of this governor being adjustable independently of the radial throw of the Governor Balls or the normal speed of the engine, the closest possible regulation can be obtained for any style of engine or motor to which a throttling Governor can be used.



CLASS A.—SHOWING AUTOMATIC STOP.

**Adapted to all varieties of Steam Engines and fitted with special valve chambers to suit any style of Gas Engine of the throttling type.**

Patented in the United States and Canada and all the principal countries of the world.

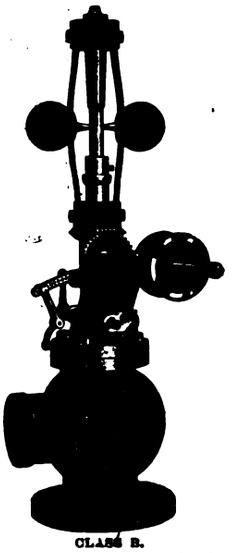


HORIZONTAL GOVERNOR.

MANUFACTURED BY THE

**Monarch Governor & Machine Co.**

INCORPORATED,
740 to 750 East Washington St.,
INDIANAPOLIS, IND., U. S. A.
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CLASS B.

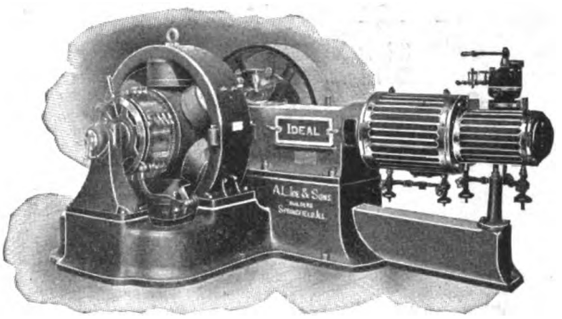

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## ENGINES

Simple and Compound.
Single and Four-Valve Automatic.
50 to 750 Horse Power.



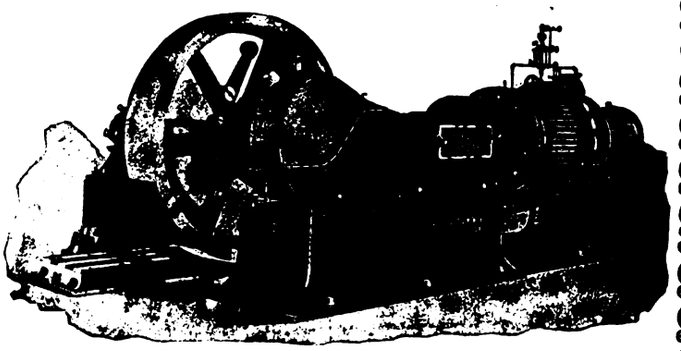

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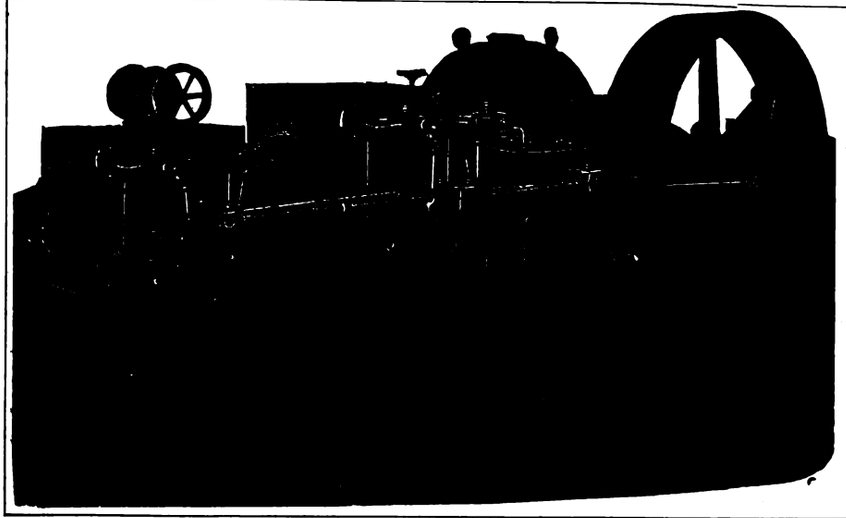
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6 TO 3,000 HORSE POWER HIGH SPEED
MEDIUM SPEED AND CORLISS



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DIRECT CONNECTED STYLE

Harrisburg Foundry and Machine Works
HARRISBURG, PA., U. S. A.



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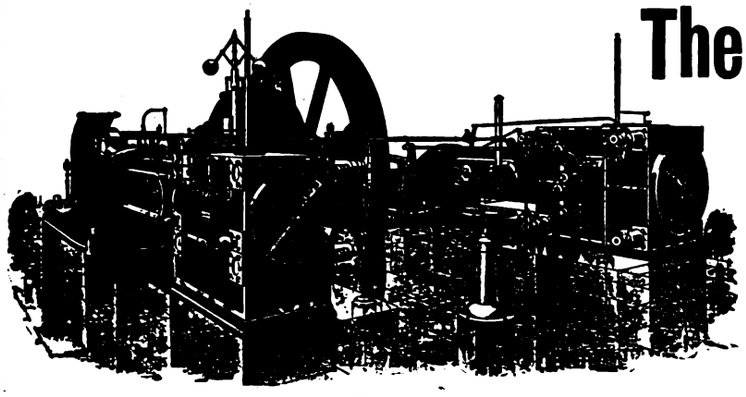
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From 50 to 3,000 H.P. with Girder or Semi-Tangye Frames.

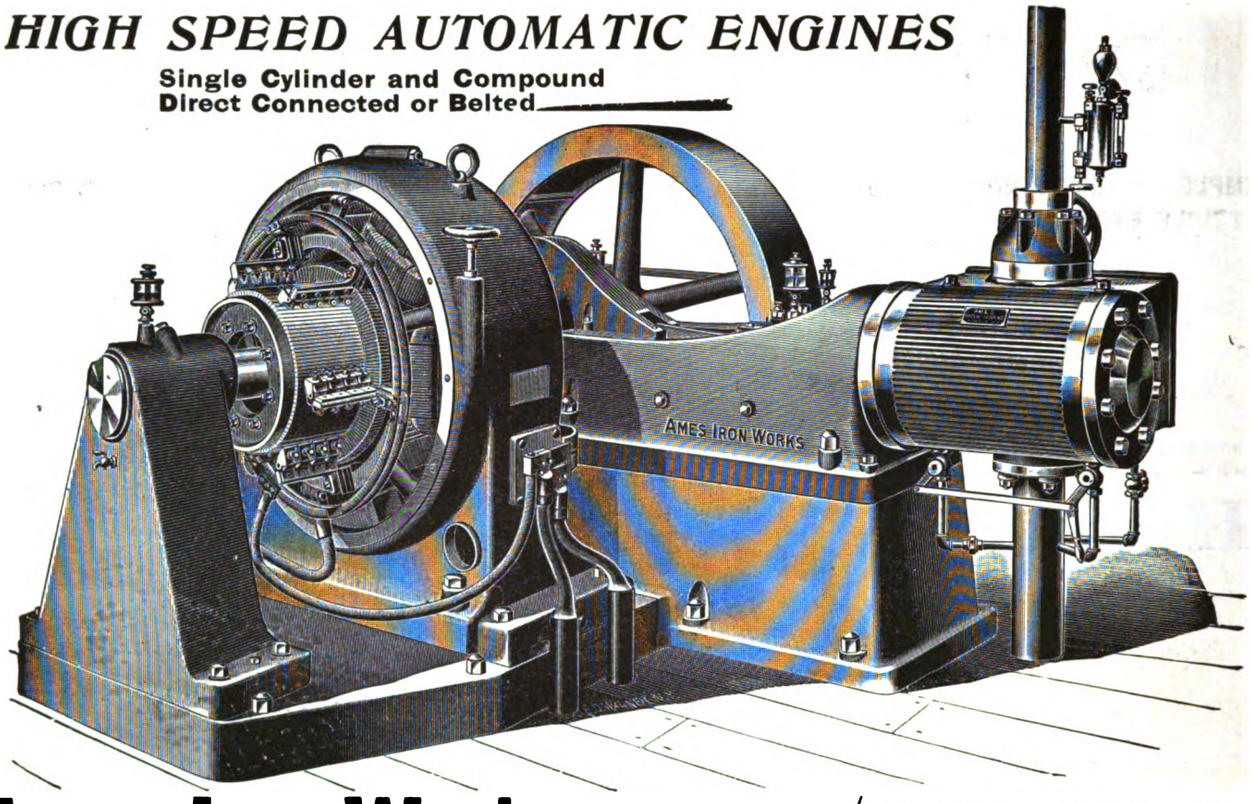
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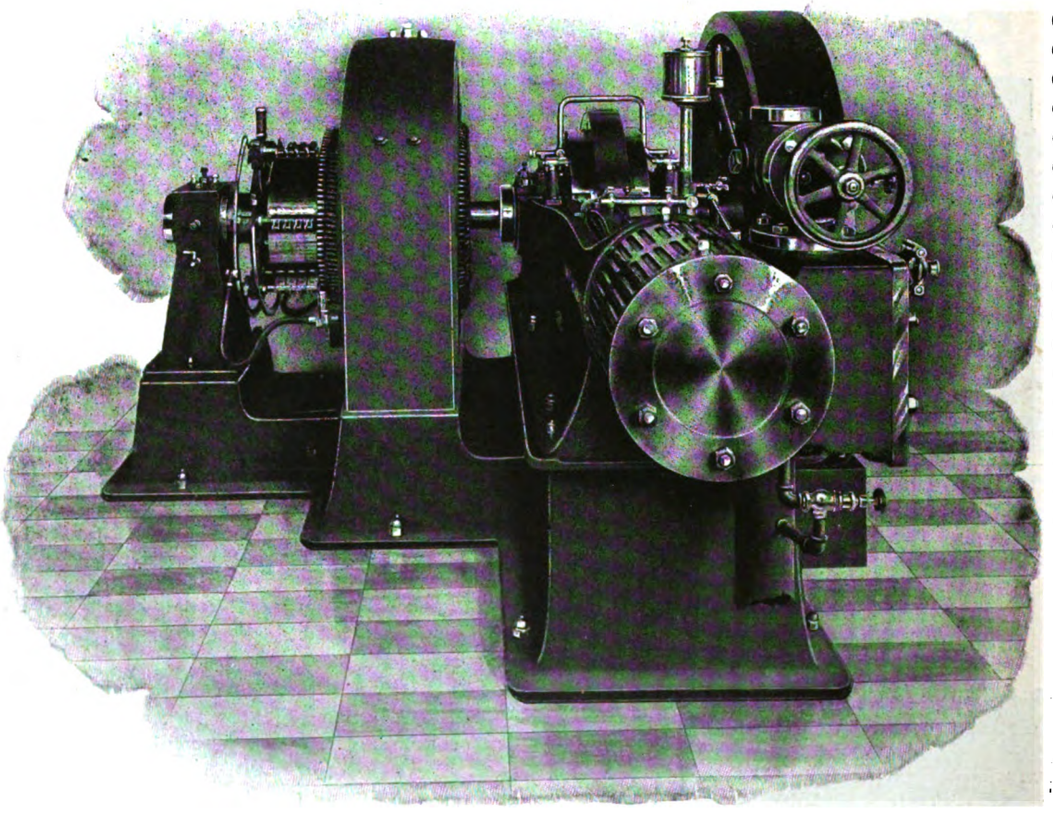



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Equipped with the most complete Automatic Oiling, Purifying, and Water Separating System ever designed.



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ALL SIZES

SIMPLE. COMPOUND. TRIPLE EXPANSION. | HORIZONTAL. VERTICAL. | TANDEM. CROSS. | BELTED. DIRECT COUPLED TO DYNAMO OR SHAFT.

*SPECIAL ENGINES TO MEET ALL REQUIREMENTS.*

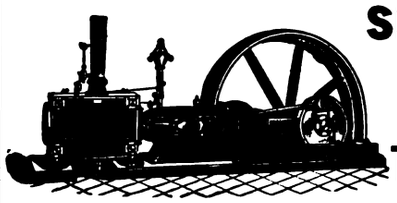
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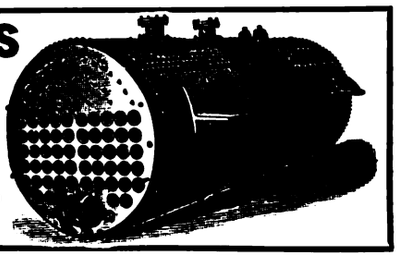
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**HIGH PRESSURE BOILERS**

TUBULAR and INTERNAL FURNACE

**THE MURRAY IRON WORKS CO.,**

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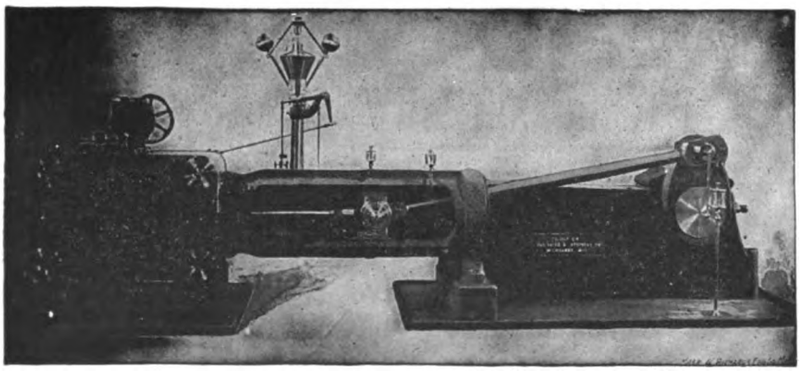
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ABSOLUTE RIGIDITY
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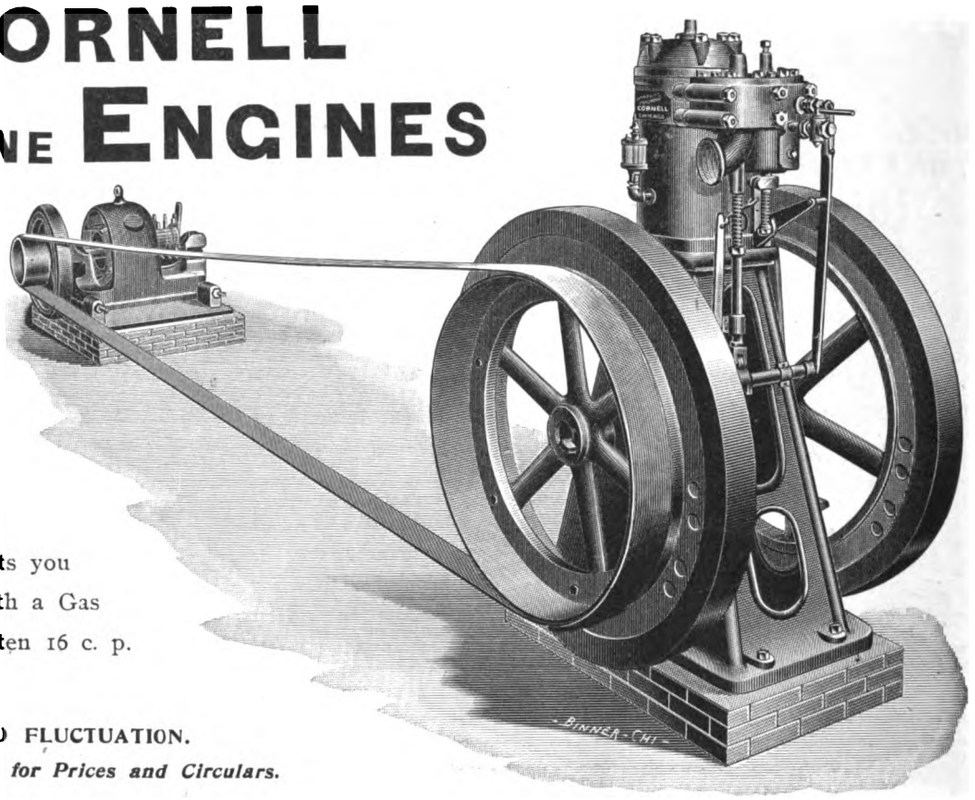
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## GAS AND GASOLINE ENGINES



***Isolated Electrical Plants***

25 to 500 16 c. p. capacity.

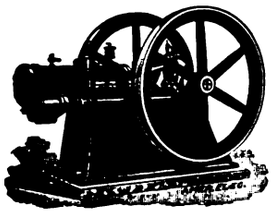
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For every five gas jets you now burn you can (with a Gas Engine Plant) obtain ten 16 c. p. incandescent lights.

ABSOLUTELY NO FLUCTUATION.

....*Write for Prices and Circulars.*

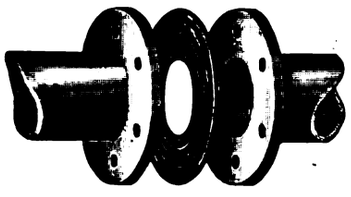
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**GAS and GASOLINE.... ENGINE.** Observe its Simplicity.

No complicated mechanism on the back side or within the bed.
Takes up its load on any revolution.
Specially adapted to electric light or general service. Send for circular "A."

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COLUMBUS, OHIO.



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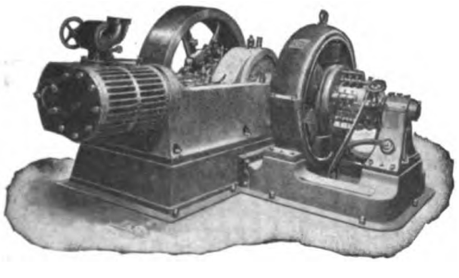
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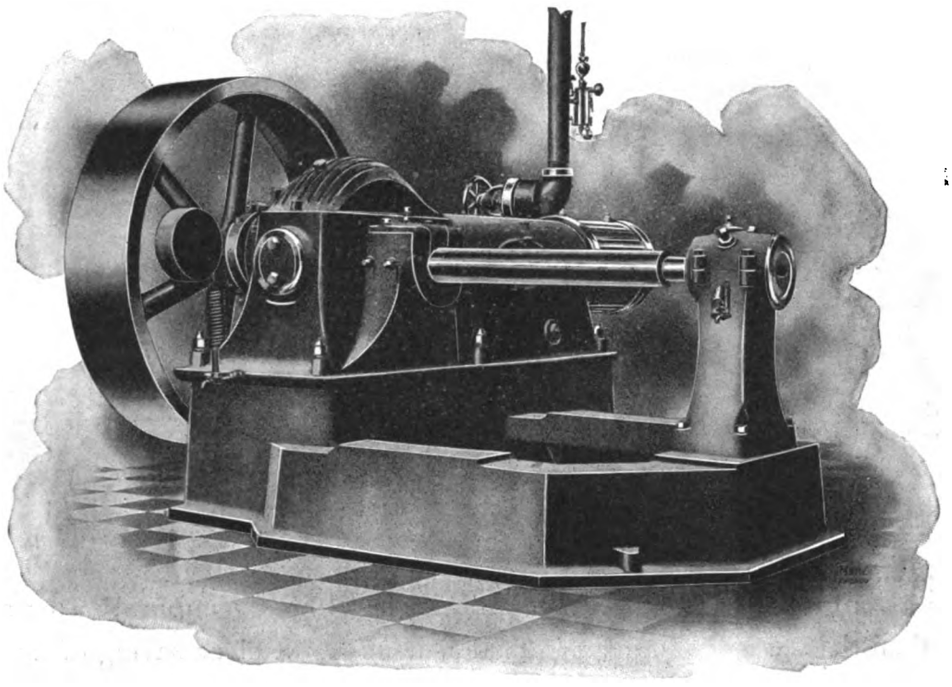
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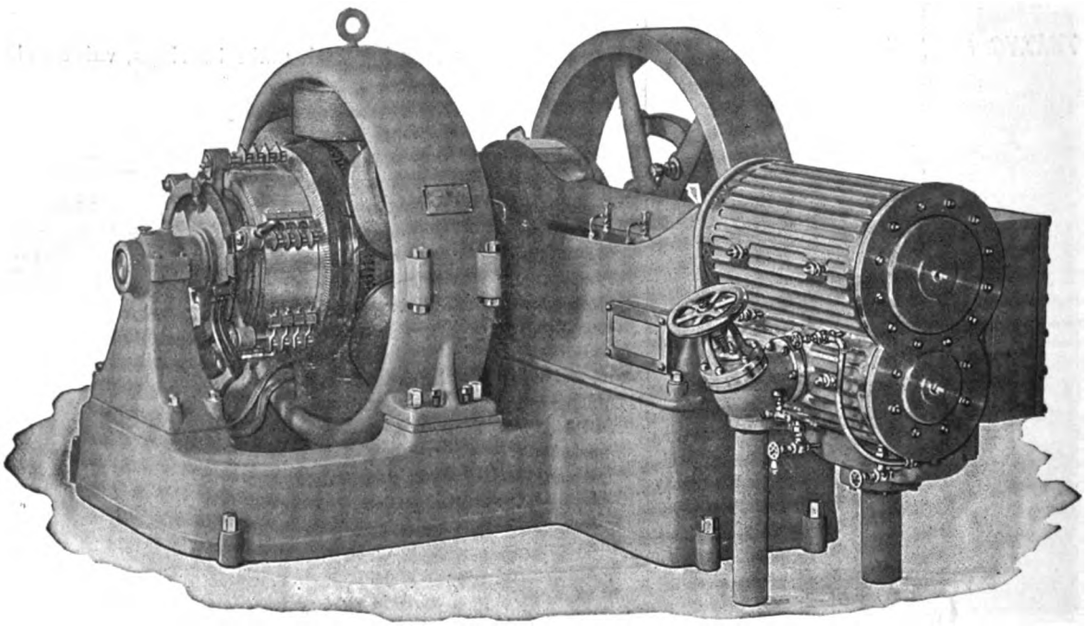

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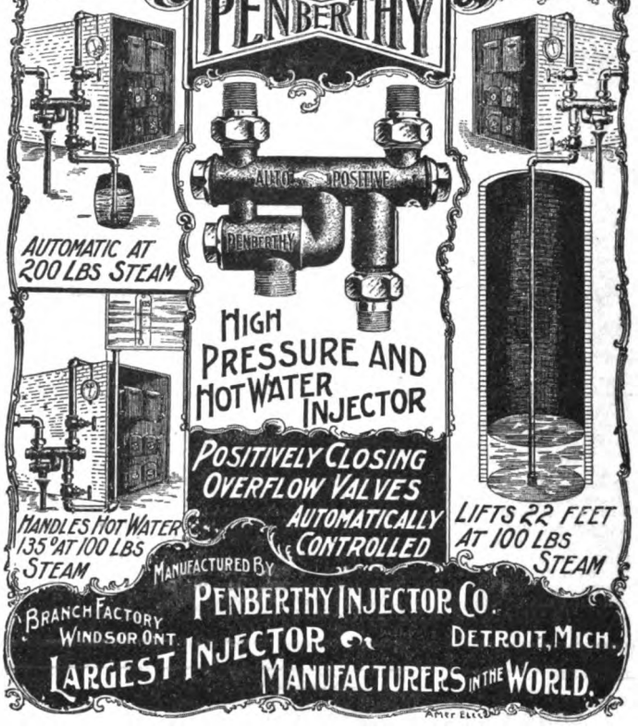
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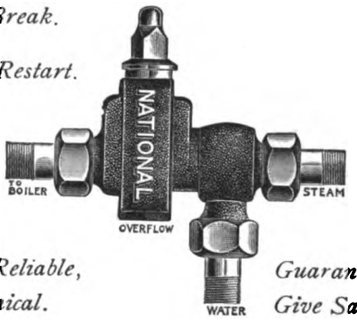

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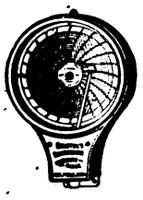




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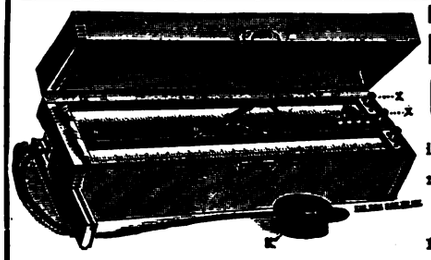
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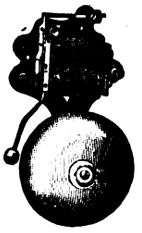


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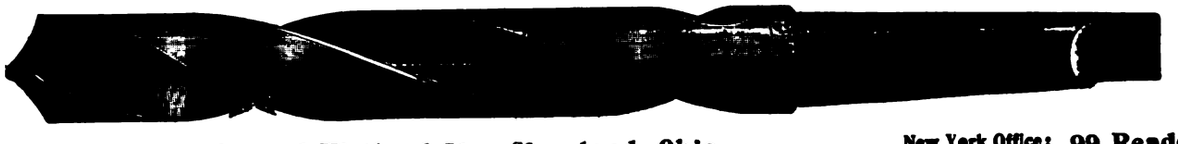
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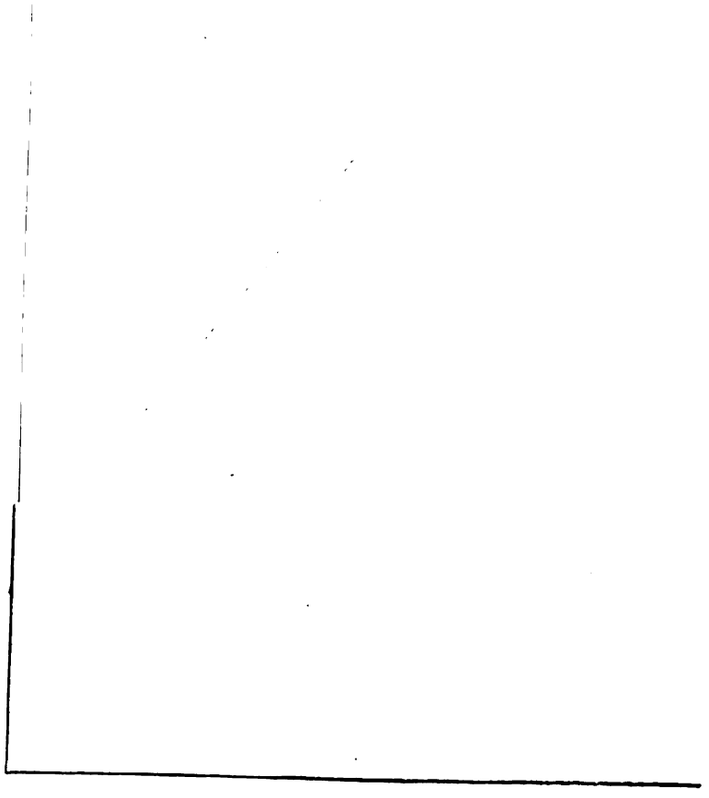
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